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Part V

Environmental Protection Agency

40 CFR Parts 141 and 142

Drinking Water Regulations; Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper; Proposed Rule

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 141 and 142

[FRL-3380-2]

Drinking Water Regulations; Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper

August 3, 1988.

AGENCY: Environmental Protection Agency.

ACTION: Proposed rule.

SUMMARY: In this notice, EPA is proposing maximum contaminant level goals (MCLGs) and national primary drinking water regulations (NPDWRs) for controlling lead and copper in drinking water. These proposed regulations would control lead and copper in drinking water that is due both to their occurrence in source waters and to the corrosion of lead and copper plumbing materials by water. EPA is proposing an MCLG of zero for lead and an MCLG of 1.3 mg/l for copper. For both lead and copper, EPA is proposing an NPDWR consisting of a treatment technique requirement which would require optimal corrosion control to minimize lead and copper as corrosion by-products and public education to reduce exposure to lead as a corrosion by-product. In addition, EPA is proposing NPDWRs specifying maximum contaminant levels (MCLs) for lead and copper in water entering the distribution system, after any treatment: 0.005 mg/l for lead and 1.3 mg/l for copper. EPA is also soliciting comment on alternatives to some of these proposals related to treatment requirements, monitoring, and lead pipe replacement.

DATES: Written comments should be submitted by October 17, 1988. Public hearings will be held at the addresses indicated below under "**ADDRESSES**" on September 28 (and 29, if necessary), 1988 in Washington, DC; on October 3 (and 4, if necessary), 1988 in Chicago, IL; and on October 6 (and 7, if necessary), in Seattle, WA.

ADDRESSES: The Agency will hold public hearings on the proposal at three different locations indicated below:

1. GSA Regional Auditorium, Seventh and D Streets SW., Washington, DC 20407, September 28 (and 29, if necessary), 1988.
2. The Federal Building, Lake View Conference Center, 16th Floor, 230 S. Dearborn St., Chicago, IL 60604, October 3 (and 4, if necessary), 1988.
3. The Park Place Building, Room 12–A, 1200 Sixth Avenue, Seattle, WA 98101, October 6 (and 7, if necessary), 1988.

The hearings will begin at 9:30 a.m., with registration at 9:00 a.m. The hearings will end at 4:00 p.m., unless concluded earlier. Anyone wishing to make a statement at a hearing should notify, in writing, Lead Public Hearing Officer, Office of Drinking Water (WH–550), U.S. Environmental Protection Agency, 401 M Street SW., Washington, DC 20460, (301) 585–1597 (Juanita Bridgewater).

Oral and written statements may be submitted at the public hearing. Persons who wish to make oral presentations are encouraged to have written copies of their complete comments for inclusion in the official record.

The public docket for this rulemaking, including major supporting documents and public comments on the proposal, will be available for review and copying during normal business hours at the EPA Drinking Water Docket, 401 M Street SW., Washington, DC 20460. For access to docket materials, call (202) 382–3027 between 9 a.m. and 4 p.m. Eastern time.

Send written comments on the proposed rule to Lead and Copper Comment Clerk, Office of Drinking Water (WH–550), Environmental Protection Agency, 401 M Street SW., Washington, DC 20460.

FOR FURTHER INFORMATION CONTACT: Gregory Helms, Office of Drinking Water (WH–550), U.S. Environmental Protection Agency, 401 M Street SW., Washington, DC 20460, (202) 382–7575, or one of the EPA Regional Office contacts listed in "Supplementary Information," below. Information may also be obtained from the EPA Safe Drinking Water Hotline. The toll-free number is (800) 426–4791 and the Washington, DC number is (202) 382–5533. The hotline is open from 8:30 a.m. to 4:00 p.m. Eastern time.

SUPPLEMENTARY INFORMATION: Major documents supporting this proposal will be available at EPA Regional Offices.

EPA Regional Offices

I. JFK Federal Bldg., Room 2203, Boston, MA 02203, Phone: (617) 565–3610, Jerome Healey

II. 26 Federal Plaza, Room 824, New York, NY 10278, Phone: (212) 264–1800, Walter Andrews

III. 841 Chestnut Street, Philadelphia, PA 19107, Phone: (215) 597–9873, Jon Capacasa

IV. 345 Courtland Street, Atlanta, GA 30365, Phone: (404) 347–2913, Wesley (Bo) Crum

V. 230 S. Dearborn Street, Chicago, IL 60604, Phone: (312) 353–2151, Joseph Harrison

VI. 1445 Ross Avenue, Dallas, TX 75202, Phone: (214) 655–7155, Thomas Love

VII. 726 Minnesota Ave., Kansas City, KS 66101, Phone: (913) 236–2815, Gerald R. Foree

VIII. 999 18th Street, Suite 500, Denver, CO 80202–2405, Phone: (303) 293–1424, Marc Alston

IX. 215 Fremont Street, San Francisco, CA 94105, Phone: (415) 974–0763, William Thurston

X. 1200 Sixth Avenue, Seattle, WA 98101, Phone: (206) 442–4092, Richard Thiel

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Glossary of Terms

Blood Lead Level or PbB Level: The concentration of lead in blood. The health effects of lead are indexed to the concentration of lead in the blood (rather than total exposure or intake), measured in micrograms of lead per deciliter of blood (ug/dl).

Corrosion: Dissolution or eroding of pipe or other plumbing material by water.

Distributed Water: Water leaving the water treatment facility and/or entering the distribution system.

Ends of The Distribution System: Those points in the water supply distribution system with low or no flow.

Fully Flushed Sample: Water collected from a tap that has been allowed to flow freely for 3–5 minutes.

Galvanic Corrosion: Corrosion of one metal accelerated by the presence of another metal with a different electrochemical potential (e.g., corrosion of lead solder is accelerated by the presence of cooper pipe).

Gooseneck or Pigtail: A short section of pipe used to connect the service line to the water main or the service line to the water meter. See Figure 1.

Lead Pipe: Any pipe containing >8 percent lead.

Lead Solder: Any solder containing >0.2 percent lead.

Morning First Draw Sample: A water sample collected at a consumer's tap that has been standing in the interior plumbing for 8–18 hours and is collected without prior flushing.

Optimal Corrosion Control Treatment: Corrosion control treatment which minimizes lead levels in targeted samples.

Random Daytime Grab Sample: A water sample collected at a consumer's tap after it has been opened at a random time of the day (standing time of the water unknown).

Service Connection: The entire connection between a building and the service main, including the service line and any gooseneck or pigtail connections between the service line and the main (See Figure 1).

Service Connection Sample: Water collected that has stood for 8–18 hours in a building service line. This sample may be collected by one of 3 methods: (1) Direct sampling of the service line; (2) tap sample collection based on a temperature change in the water; or (3) tap sample collection after flushing a volume of water equal to that contained in pipes leading from the tap to the service line.

Service Line: The section of pipe connecting the water main to the interior plumbing of a house or building. See Figure 1.

Targeted Samples: Samples which have been taken in accordance with the monitoring requirements to determine compliance with the treatment technique requirements for corrosion control.

Abbreviations

BAT: Best Available Technology
CWSS: Community Water Supply Survey
MCL: Maximum Contaminant Level
MCLG: Maximum Contaminant Level Goal
MDL: Method Detection Limit
MGD: Million Gallons per Day
NIRS: National Inorganics and Radionuclide Survey
NOMS: National Organics Monitoring Survey
NPDWR: National Primary Drinking Water Regulation
NSDWR: National Secondary Drinking Water Regulation
NTNCWS: Non-Transient Non-Community (Water System)
PQL: Practical Quantitation Limit
PWS: Public Water System
SDWA: Safe Drinking Water Act
VOC: Volatile Organic Chemical

I. Statutory Requirements

The Safe Drinking Water Act (42 U.S.C. 300f *et seq.)* ("SDWA" or "the Act") requires EPA to establish maximum contaminant level goals (MCLGs) and national primary drinking water regulations (NPDWRs) for contaminants which, in the judgment of the Administrator, may have any adverse effect on the health of persons and which are known or anticipated to occur in public water systems. Section 1412(b)(3)(A). MCLGs and MCLs are to be proposed and promulgated simultaneously. Section 1412(b)(1).

MCLGs are Non-enforceable Health Goals

MCLGs are to be set at a level at which, in the Administrator's judgment,

"no known or anticipated adverse effects on the health of persons occur and which allows an adequate margin of safety." Section 1412(b)(4). The House Report on the bill that eventually became the SDWA of 1974 provides Congressional guidance on developing MCLGs:

> [T]he recommended maximum contaminant level [renamed maximum contaminant level goal in the 1986 amendments to the SDWA] must be set to prevent the occurrence of any known or anticipated adverse effect. It must include an adequate margin of safety, unless there is no safe threshold for a contaminant. In such a case, the recommended maximum contaminant level should be set at the zero level. (H.R. Rep. No. 93–1185, Pg. 20, 1974)

NPDWRs Set the Enforceable Standards

NPDWRs include either MCLs or treatment technique requirements as well as compliance monitoring requirements. Section 1401(1). A treatment technique requirement can be set only if "it is not economically or technologically feasible to ascertain the level of the contaminant." Section 1412(b)(7)(A). The MCL for a contaminant must be set as close to the MCLG as is "feasible." Section 1412(b)(4). Feasible means "feasible with the use of the best technology, treatment techniques and other means, which the Administrator finds after examination for efficacy under field conditions and not solely under laboratory conditions are available (taking costs into consideration.)" Section 1412(b)(5). A treatment technique must "prevent known or anticipated adverse effects on the health of persons to the extent feasible." Section 1412(b)(7)(A).

Secondary MCLs

EPA sets national secondary drinking water regulations (NSDWRs) to control water color, odor, appearance, and other characteristics affecting consumer acceptance of water. The secondary regulations are not federally enforceable, but are considered guidelines for the States. Section 1401(2).

Amendments to the SDWA

The 1986 amendments to the SDWA established a list of 83 contaminants for which EPA is to develop MCLGs and NPDWRs. Lead and copper are among these contaminants, and this proposed rule is the first step in fulfilling this statutory requirement for lead and copper in drinking water.

II. Background

A. Regulatory Background

The current MCL for lead is 0.050 mg/l (see 40 CFR 141.11(b)). EPA promulgated this MCL as an interim drinking water regulation in 1975. For copper, there is currently a NSDWR of 1 mg/l. On November 13, 1985, EPA began the process of revising the standards for lead and copper by proposing MCLGs for them (50 FR 46936, November 13, 1985). Because the 1986 amendments to the SDWA require that MCLGs and NPDWRs be proposed and promulgated simultaneously, EPA must repropose MCLGs for contaminants for which MCLGs were originally proposed in the November 1985 notice, including lead and copper, when it proposes the corresponding NPDWRs. Accordingly, this notice, which proposes NPDWRs for lead and copper, also reproposes MCLGs for these contaminants. The MCLG proposed for lead in this notice (zero) is lower than the MCLG for lead proposed in November 1985. The MCLG proposed for copper is the same as that proposed in 1985 (1.3 mg/l).

1. Lead

The November 1985 notice proposed an MCLG for lead of 0.020 mg/l. This goal was based on an assessment of data on adverse health effects of lead on infants. The assessment concluded that blood lead levels of 15 to 20 ug/dl represented levels of concern for infants. Effects of lead found at these levels are discussed in detail in the November 1985 notice; more recent data on these and other effects are discussed below. The 1985 proposed MCLG of 0.020 mg/l for lead in water assumed that 15 ug/dl was the blood lead level of concern for infants, assumed that infants receive 100 percent of their lead exposure from drinking water, and used a factor of 0.16 ug/dl per ug/l lead to correlate water lead levels to blood lead levels (i.e., every 1 ug/l lead in drinking water was estimated to contribute about 0.16 ug/dl to a child's blood lead level). An uncertainty factor of 5 was used in the calculation to account for uncertainty in the data and provide a margin of safety.

There also are several positive carcinogenicity bioassays using different lead salts. Therefore, in the November 1985 notice, EPA classified lead as a Group B2 carcinogen (probable human carcinogen) according to the draft EPA Guidelines for Carcinogen Risk Assessment (since promulgated as final guidelines at 51 FR 33992, September 24, 1986). However, the proposed MCLG was not based on the carcinogenicity data because the doses used in the studies were much higher than the overt toxicity levels in humans, and because several epidemiology studies did not show an association between cancer and lead exposure in occupationally exposed workers.

In addition to directing EPA to revise the NPDWR for lead, the SDWA includes other provisions that affect lead contamination of drinking water. The 1986 SDWA amendments banned the use of lead solder or flux (i.e., solder or flux containing more than 0.2 percent lead) and lead-bearing pipes and fittings (i.e., pipes and fittings containing more than 8 percent lead). Section 1417. The lead ban was effective June 19, 1986. States were required to implement and enforce the lead ban as of June 19, 1988. EPA is developing a program to withhold 5 percent of Federal grants for drinking water implementation from States that fail to enforce the ban.

The SDWA also imposes special public notification requirements regarding lead in drinking water. Section 1417(a)(2). Public water systems are required to identify and provide notice to persons who may be affected by lead contamination in their drinking water, when such contamination results from either the use of lead in the construction materials of the system and/or corrosivity of the water supply sufficient to cause lead leaching from plumbing systems. This provision requires notification even if the system is in compliance with the current MCL for lead. EPA published final regulations to implement this requirement of the SDWA on October 28, 1987 (52 FR 41534). Under these regulations, systems were required to begin providing notice to consumers by June 19, 1988.

2. Copper

EPA proposed an MCLG of 1.3 mg/l for copper in the November 13, 1985 notice. This value was based on short-term effects of copper on humans at relatively high doses; no long-term effects at lower exposure levels have been predicted. No new data have become available since November 1985 that have altered EPA's evaluation of the health effects of copper.

B. Overview of Problem

1. Lead

Lead occurs in drinking water from two sources: (1) Lead in raw water supplies, i.e., source water, and (2) corrosion of plumbing materials in the water distribution system. Most of the lead in drinking water is a result of corrosion by water of plumbing materials containing lead.

EPA estimates that approximately 900 public water systems (or <1 percent of the community water systems in the country) may have water leaving the

water supply plant that has greater than 0.005 mg/l lead. In fact, some systems deliver water to customers that exceeds the current MCL of 0.050 mg/l. Because of concern about low level exposures to lead, as described in Section III.B.1. below, lead in source water even at low levels may be an important contributor to lead in drinking water in some systems.

Lead in drinking water as a by-product of corrosion results primarily from corrosion of plumbing materials in the distribution system and in buildings. The amount of lead in drinking water due to corrosion depends on a number of factors, including the amount and age of lead material present in the system to be corroded and the degree of corrosivity of the water.

As illustrated in Figure 1, potential sources of lead in drinking water distribution systems (including plumbing in buildings) include:

- Water service mains (rarely);
- Lead goosenecks or pigtails (short sections of pipe leading from the water main to the meter or main portion of the service line, and which is genrally 6–8 feet long);
- Lead service lines and interior household pipes;
- Lead solders and fluxes used to connect copper pipes; and
- Alloys containing lead, including some faucets made of brass or bronze.

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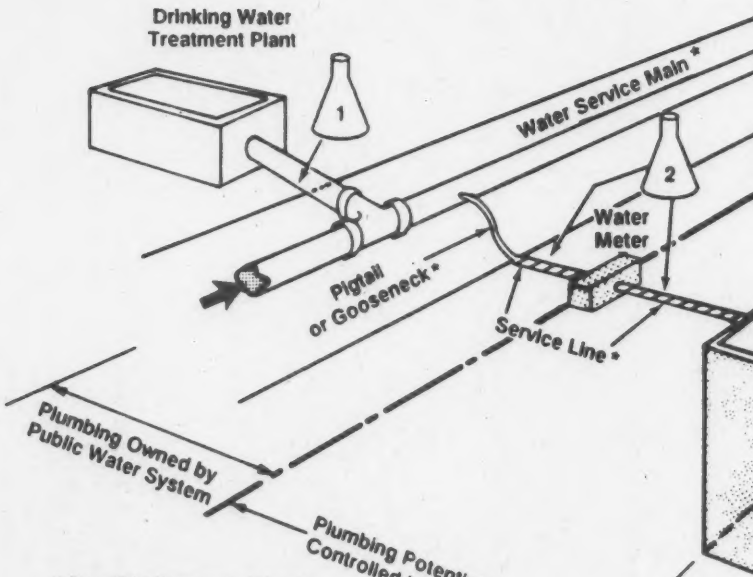
Public Water System



* Possible Sources of Lead
  - Pipe
  - Solder
  - Brass Fitting
  - Service Main (rarely)

= Sample

= Plant Sample

= Service Line Sample (Collected at Tap)

= Tap Sample

BILLING CODE 6560-50-C

Figure 1

n and Homeowner Plumbing

Most public water systems serve at least some buildings with lead solder and EPA estimates that there are about 4.4 million lead service lines still in use in the U.S. About 25 percent of water suppliers have some lead service lines within their distribution system (EPA, 1987a). Lead service lines and interior plumbing are significant potential sources of lead in drinking water and can contribute large amounts of lead to water for the life of the pipe. Lead solder can contribute large amounts of lead to water for up to five years after installation, and longer if exposed to corrosive water (EPA 1986a). In addition, brass and bronze in faucets and fixtures can contain lead and there is evidence that they can be an important source of lead in drinking water that stands in the fixtures.

The amount of lead in drinking water also depends on the corrosivity of the water. All water is corrosive to metal plumbing materials to some degree, even water termed non-corrosive or water treated to make it less corrosive. The corrosivity of water to lead is influenced largely by the pH and total alkalinity of the water (water with low pH and/or low alkalinity water is more corrosive to lead than water with high pH and alkalinity). Galvanic corrosion of lead into water also occurs with lead-soldered copper pipes, due to differences in the electrochemical potential of the two metals. Grounding of household electrical systems to plumbing can exacerbate galvanic corrosion. There are other factors that also may affect water corrosivity, such as water temperature (seasonal variations in lead levels are common), and levels of free chlorine, total dissolved solids, and oxygen.

Lead levels in drinking water can vary considerably from system to system, among houses supplied by the same system, among different taps in the same house, and at different times of the day at a single tap. Factors that affect lead levels in water independent of the corrosivity of water include:

- The number and age of lead-soldered joints in the building and the quality of workmanship of the joints (new solder releases high amounts of lead and sloppy solder joints have more lead available to be leached);
- The contact time between the water and the lead (longer contact time results in higher lead levels so, for instance, morning first draw water samples have higher lead levels than samples with shorter standing times or flushed water samples); and
- The length and diameter of the lead service line (longer lines generally result in higher lead levels in water at the tap since the water is in contact with more lead, while smaller diameter pipes have a greater ratio of pipe surface to water volume so there is more contact between the lead and water which can result in higher lead levels, and small diameter pipes can also result in higher lead levels because of increased velocity of the water flow which causes scouring of the sides of the pipe).

2. Copper

The primary source of copper in drinking water is corrosion of copper pipes, which are widely used throughout the U.S. for interior plumbing of residences and other buildings; copper in source water is a problem for very few water supplies. In some cases, copper is a component of additives to drinking water used by suppliers to control the growth of algae. EPA estimates that only 66 water suppliers would need to install treatment to reduce copper in source water to the MCLG (EPA, 1988a).

Like lead in drinking water, the occurrence of copper in drinking water resulting from corrosion when copper is present in the distribution system, including interior plumbing, depends on the corrosivity of the water. Also, as with lead, all water is corrosive to copper to some degree. Corrosivity toward copper depends primarily on the pH of the water, with very low pHs associated with the highest levels of copper in water due to corrosion. Free chlorine levels also affect corrosion of copper; higher chlorine residual levels increase copper corrosion (Stone et al., 1987; Reiber et al., 1987; EPA, 1987b). Dissolved carbon dioxide and oxygen can also contribute to copper corrosion (Cohen and Meyers, 1987).

Many of the other factors that affect the corrosivity of water towards lead can also be expected to affect the corrosion of copper. For instance, flow rate, standing time, water temperature, and length of copper pipe can affect copper levels in drinking water (Maessen et al., 1985). There are few data on whether age of plumbing affects copper corrosion rates (EPA, 1987b; Rieber et al., 1987).

III. MCLGs for Lead and Copper

A. Exposure

1. Exposure to Lead

a. *General.* Assessing actual human exposure to lead is difficult due to the variability of lead levels at the tap and the existence of other exposure sources. As described above, water lead levels at any one tap vary throughout the day, and vary among taps with constant standing times due to differences in the amount of available lead to which the water is exposed.

People are exposed to lead from a variety of sources in addition to water, including food, air, and dust; the proportion of total exposure attributable to drinking water varies by individual. The typical drinking water contribution to total lead exposure for an average two-year-old child is estimated to be about 20 percent (EPA, 1988b), but this varies with different levels of lead in the water and with variations in other lead exposures, and can range from about five to 30 percent of total intake. For children with extraordinary exposures, such as those exposed to deteriorating lead paint, including paint chips or leaded-paint dust, or living near lead smelters or other point sources of airborne lead, those sources predominate and drinking water contributes a much lower, although still relevant, proportion of total exposure. For residents of buildings with new lead solder served with corrosive water, drinking water can be the primary source of exposure.

b. *Exposure to Lead Through Drinking Water.* The magnitude of human exposure resulting from the ingestion of lead in drinking water depends upon many factors. Patterns of consumption may vary among individuals, from those who flush taps before drinking to those who drink first flush water. There are few actual data on individual water consumption patterns (i.e., percent consumption of standing and flushed water) and the lead exposures that result from them. EPA is conducting a pilot study of drinking water consumption patterns which may provide additional data on this question for use in developing the final MCLG and enforceable standards. However, these data are not yet available.

The problem of assessing exposure from drinking water can be addressed by bracketing exposures. Assuming that an adult consumes two liters of water (one liter for children) per day from the same water supplier, morning first draw samples (or service connection samples if the service connection is lead) will represent a case of high exposure and fully flushed samples will represent the minimum exposure. For example, in a home where fully flushed samples are consistently 0.005 mg/l and morning first draw (or service connection) samples are consistently 0.010 mg/l, the occupants will have actual lead intake from drinking water of 0.005–0.010 mg/l, or a total of 0.010–0.020 mg/day for adults.

Patterson (EPA, 1981) conducted a national study of lead levels in drinking

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water. Random daytime grab samples from taps that had been flushed for 30 seconds were collected from 580 cities in 47 states. While 30-second flushed random grab samples are not necessarily representative of actual human exposure, EPA believes that they are more representative of water consumed in the U.S. than are fully flushed samples since many people regularly consume some morning first draw water. Because these data portray neither an upper bound of exposure (morning first draw or lead service line sample levels) nor a lower bound of exposure (fully flushed) levels, they may more closely portray actual average exposure. Therefore, these data provide insight as to the magnitude of lead exposure via drinking water. In the Patterson study, which used a reporting limit of 0.010 mg/l, the national mean lead level in water was 0.029 mg/1. The midwest had the highest mean lead level (0.047 mg/l) and the south-central portion of the country had the lowest mean lead level (0.012 mg/l). The median value for the U.S. and for all of the regions of the country identified in the analysis was the reporting limit, 0.010 mg/l. An EPA analysis of the benefits of regulating lead in drinking water used these data to estimate that 42 million people in the U.S. may be exposed to lead levels in water of 0.020 mg/1 or greater (EPA, 1986a).

As discussed in Section III.B. below, the toxic effects of lead are correlated with blood lead levels rather than lead exposure levels or intake amounts. Therefore, it is important to understand the relationship between lead intake and blood lead levels. Many investigators have attempted to correlate blood lead levels with drinking water lead levels and estimate the contribution of water lead to blood lead levels. Several of these studies correlated morning first draw water lead levels with blood lead levels (U.K. Dept. of Environment, 1982; Thomas et al., 1979). Other studies correlate standing random daytime grab sample water lead levels with blood lead levels (Worth et al., 1981; Moore, 1977). While neither morning first draw nor standing random daytime grab data is a better predicator of blood lead level than the other, of the currently available data, both are better than fully flushed samples (EPA, 1986b). Duplicate diet studies by Ryu (1983) and Lacey et al. (1985) have correlated measured lead intake with blood lead levels, and can also be used to predict blood lead levels. EPA has used a correlation coefficient of 0.20 ug/dl per ug/1 derived from these last two studies to relate lead levels in drinking water to blood lead levels (EPA, 1988c).

c. *Non-Drinking Water Exposures to Lead.* There are several sources of lead exposure in addition to drinking water. Directly inhaled airborne lead and lead that settles out to dust and dirt from the air are important sources, especially for children who tend to play in the dirt and who often put their hands in their mouths. Other important sources of lead are air deposition on food crops, leaching to food from lead soldered cans, and in the case of exceptionally high exposures, lead paint.

Lead in air arises from industrial emissions and combustion of leaded gasoline in cars. EPA estimates that average urban air lead levels ranged between 0.2–0.4 ug/m^3 in 1986 (EPA, 1988d). Much higher levels are found in areas near stationary lead sources such as smelters and battery plants.

Ingestion of leaded paint chips and dust accounts for most of the reported cases of overt lead poisoning in children. Many local community health programs (especially in urban areas) screen the blood lead levels of children and identify high risk housing (i.e., those houses likely to have deteriorating lead paint) and assist with remediation of lead paint problems.

Food is also a source of lead exposure. Lead can contaminate food by uptake from soil, direct deposition on crops from the air, or use of lead solder to seal cans (especially with acidic foods such as tomatoes). The Food and Drug Administration has recommended the use of non-lead soldered cans for baby foods and encourages food processors to eliminate the use of lead-soldered cans for all foods. In the U.S., no baby foods are currently sold in lead-soldered cans and most domestic can manufacturers have voluntarily converted to lead-free cans for other foods as well. In addition, lead can contaminate food in the handling, transportation or preparation stages. Finally, food prepared with water, either in manufacturing or at home, can be contaminated by lead from the drinking water.

The Agency for Toxic Substances and Disease Registry (ATSDR) has compiled a report to Congress on lead hazards and exposures of children (ATSDR, 1988). The ATSDR report reviews the non-drinking water sources of lead exposure in greater detail than is presented here.

2. Exposure to Copper

Human exposure to copper results from a variety of sources, including drinking water. As described earlier, copper in drinking water occurs primarily as a result of the corrosion of copper plumbing pipes, although some copper occurs in raw water.

Patterson (EPA, 1981) measured copper levels in the 30-second flushed random daytime grab samples described above. In that survey, 3 percent of 772 samples exceeded 1 mg/l of copper and 19 percent exceeded 0.2 mg/l. The national average level of copper in water was 0.221 mg/l (median 0.04 mg/l), the south central U.S. had the lowest average levels (0.082, median, 0.02 mg/l), and the northeast had the highest average levels (0.526 mg/l; median, 0.06 mg/l).

Exposure to copper can also come through air and food. In a 1966 National Air Sampling Network survey, copper levels in the air were 0.01 and 0.26 $\mu g/m^3$ in rural and urban areas, respectively (U.S. Dept. of Health, Education, and Welfare, 1968). Airborne copper levels near copper smelters can range up to 2 $\mu g/m^3$, but even these high levels contribute only about 1 percent of normal daily intake. Copper is found in shellfish and organ meats, nuts, and dried legumes; dried vine and stone fruits and cocoa are especially rich in copper. Copper levels can range up to 400 $\mu g/g$ in these foods (50 FR 46967, Nov. 13, 1985).

B. Toxicity

1. Health Effects of Lead

As noted above, the health effects of lead are generally correlated with PbB levels. Lead exposure across a broad range of blood lead (PbB) levels is associated with a continuum of pathophysiological effects, including interference with heme synthesis necessary for formation of red blood cells, anemia, kidney damage, impaired reproductive function, interference with vitamin D metabolism, impaired cognitive performance (as measured by IQ tests, performance in school, and other means), delayed neurological and physical development, and elevations in blood pressure (EPA, 1986b).

At this time, it is difficult to identify clearly what PbB level is an appropriate criterion or "threshold" below which there are no or only minimal risks of adverse health effects. Although there is some uncertainty regarding the point at which subtle biochemical or other changes combine to cause a discernable adverse effect on organs or systems in the body, effects clearly become more pronounced and broaden to cause more severe disruptions of the normal functioning of many organ systems as PbB levels increase. The following

considerations are important in determining a target PbB of concern to be used in setting an MCLG.

PbB levels above 30 μg/dl in young children are associated with clearly deleterious effects in several organ systems (EPA, 1986b). These include reduced hemoglobin synthesis (at 40 μg/dl), frank anemia (at 70 μg/dl), peripheral neuropathies (at 60 μg/dl), encephalopathy (at 80–100 μg/dl), and in some cases, death.

At levels below 25–30 ug/dl, many different, less obvious effects indicate interference by lead with normal physiological processes. The onset of signs of detectable heme synthesis impairment in many different organ systems occurs at PbB levels starting around 10–15 μg/dl, along with indications of pyrimidine and vitamin D metabolism interference and signs of altered nervous system activity (EPA, 1986b).

Evidence also indicated that fetal exposure at PbB levels around 10–15 μg/dl is associated with delays in early mental and physical development (EPA, 1986b; Davis and Svendsgaard, 1987).

In adults, several studies have found a small but consistent relationship between blood lead levels and blood pressure, with some indications of a continuous relationship down to the lowest levels measured. The blood pressure increases may be associated with some increased risk for more serious cardiovascular disease events, especially if PbB levels are chronically elevated (EPA, 1986a).

Some of the important effects of low-level lead exposures are:

1. Inhibition of pyrimidine-5-nucleotidase (Py–5–N) and delta-aminolevulinic acid dehydrase (ALA–D) activity, which appears to begin at a PbB level of 10 μg/dl or below (Angle et al., 1982). Hernberg and Nikkanen (1970) found 50 percent inhibition of ALA–D activity at PbB levels above 16 μg/dl. Inhibition of erythrocyte ALA–D appears to occur at virtually all blood lead levels measured so far, with no evident threshold (EPA, 1986b). Inhibition of ALA–D activity is manifested in increased levels of aminolevulinic acid (ALA) in blood and soft tissue, which appear to occur at PbB levels of about 40 μg/dl (O'Flaherty et al., 1980) and may occur at levels as low as 18 μg/dl (Meredith et al., 1978). Several studies indicate that increases of ALA in the brain interfere with the gamma-aminobutyric acid (GABA) neurotransmitter system in various ways (EPA, 1986b).

2. Elevated levels of erythrocyte protoporphyrin (EP) in red blood cells occurs at PbB levels as low as 15 μg/dl. This probably indicates a general interference in heme synthesis throughout the body, including interference in the functioning of mitochondria (Piomelli et al., 1980). Changes in heme metabolism have been reported perinatally at blood lead levels of 8–10 μg/dl (Lauwerys et al., 1978). Some studies that accounted for iron status show that children with low iron stores are more sensitive to lead in terms of heme biosynthesis interference (e.g., Mahaffey and Annest, 1986).

3. Interference with vitamin D metabolism has been associated with lead exposure with no apparent threshold down to the lowest PbB level measured (12 ug/dl) in studies by Rosen et al. (1980) and Mahaffey et al. (1982).

4. Correlations between lead exposure and changes in electrophysiological functioning of the nervous system have also been reported. These include correlations with: Changes in slow-wave electroencephalogram (EEG) patterns, increased latencies in brainstem auditory evoked potentials (Otto et al., 1981, 1982, 1985), and slowed nerve conduction in the auditory pathway associated with PbB levels with no clearly discernable threshold apparent down to 6 ug/dl (Schwartz and Otto, 1987). Also, peripheral nerve conduction velocities have been shown to be slowed in children, with significant correlation at PbB levels above 20 ug/dl (Landrigan et al., 1976; Schwartz et al., 1988).

5. As stated in recent reviews (Davis and Svendsgaard, 1987; EPA, 1986b), evidence from longitudinal studies in several different communities consistently indicates that perinatal exposure to blood lead levels as low as 10–15 ug/dl, and possibly lower, is linked to delays in early cognitive and physical development. Four independent studies show an association between maternal or cord blood lead levels at birth and reduced performance on a standard index of infant mental development through two years of age (e.g., Bellinger et al., 1984, 1987; Dietrich et al., 1987; Baghurst et al., 1987; Wolf et al., 1985). In addition, birth weight and the length of gestation appear to be reduced in prenatally lead-exposed infants in some of these studies (e.g., Dietrich et al., 1987; Bornschein et al., 1988; McMichael et al., 1986). Analyses also suggest that growth and stature are reduced in older children with PbB levels ranging from 5 to 35 ug/dl (Schwartz et al., 1986), with supporting evidence from other studies of children at higher PbB levels (Lauwerys et al., 1986) and of experimental animals (Grant et al., 1980). Other aspects of physical development may also be disturbed by prenatal lead exposure (Davis and Svendsgaard, 1987; EPA, 1986b).

6. Recent studies of IQ effects in black children of uniformly low socioeconomic status (SES), so that SES was not a confounder, have shown a highly significant association between IQ and blood lead across a range of 6 to 47 ug/dl (Schroeder et al., 1985; Schroeder and Hawk, 1987). Other recent cross sectional studies also provide consistent evidence of IQ deficits in children at PbB levels below 25 ug/dl (Fulton et al., 1987; Hatzakis et al., 1987).

Finally, based on the weight of evidence, EPA has classified lead as a probable human carcinogen (Group B2), because some lead compounds cause real tumors in experimental animals (EPA, 1988e). EPA (1986b) noted that lead may act as a promoter or initiator of carcinogenesis and that *in vitro* studies support the genotoxic and carcinogenic role of lead. However, EPA recommends that quantitative estimates of the carcinogenic potency of lead not be used for the purpose of risk assessment, because of the considerable uncertainty in the estimates. As EPA has stated previously, "lead has been observed to increase tumorigenesis rates in animals only at relatively high concentrations, and therefore it does not appear to be a potent carcinogen." (EPA, 1986b). At low levels, the non-cancer effects of lead are of greatest concern for regulatory purposes.

In reviewing the information presented in the Agency's 1986 Air Quality Criteria Document, EPA's Clean Air Science Advisory Committee concluded that the various effects starting at PbB levels around 10–15 ug/dl or even lower in young children "may be argued as becoming biomedically adverse" (EPA, 1986c).

Although no threshold is apparent for various measures of lead toxicity, some distinction can be made between PbB levels where risks of effects appear more likely (10–15 ug/dl and higher) and levels where risks are less certain (below 10–15 ug/dl). Therefore, 10–15 ug/dl constitutes an appropriate range of concern for health effects that warrant avoidance.

2. Health Effects of Copper

The health effects of copper were discussed in detail in EPA's 1985 MCLG proposal (50 FR 46967, November 13, 1985). No new relevant information on the health effects of copper that alters the conclusions reached in that notice has become available. The information presented in the November 1985 notice is summarized here.

Copper is toxic to humans at high levels and is nutritionally essential at lower doses. Acute exposure to high copper levels in test animals and humans can cause gastrointestinal distrubances, liver damage, renal damage, hemolytic anemia, and glucose–6–phosphate dehydrogenase (G6PD) inhibition. Chronic toxicity data are limited.

Two groups are at increased risk from copper exposure. Individuals with Wilson's disease, an inborn error in copper metabolism, are at higher risk than the general public. The metabolic error in Wilson's disease allows copper to accumulate in the liver, brain, kidney, and cornea, causing hemolytic anemia, neurological abnormalities, and corneal opacity. In addition, individuals with existing G6PD deficiencies may also be at greater risk of experiencing toxic effects from copper exposure.

On the other hand, copper is regarded as nutritionally essential because it is required in many enzymatic reactions in mammals. Copper deficiency can result in decreased iron absorption and iron deficiency, and may also lead to reproductive abnormalities. The National Academy of Sciences has recommended 2–3 mg/day copper as a safe and adequate intake (NAS, 1980).

Copper is classified in EPA's Group D (insufficient data) for carcinogenic potential. Copper is generally negative in mutagenicity bioassays and copper produced equivocal results in carcinogenicity bioassays. Bioassays using oral copper were negative; subcutaneous injection of copper compounds has been reported to induce tumor formation in one sex and strain of mice.

C. Development of the MCLGs

1. MCLG for Lead

EPA is proposing to set the MCLG for lead at zero, based on subtle effects at low blood lead levels, the overall Agency goal of reducing total lead exposures, and probable carcinogenicity at very high doses. Specifically, the basis for proposing the MCLG at zero is:

1. The occurrence of a variety of low level effects for which it is currently difficult to identify clear threshold PbB levels below which there are no risks of adverse health effects;

2. The Agency policy goal that drinking water should contribute minimal lead to total lead exposures because a substantial portion of the sensitive population already exceeds acceptable blood lead levels; and

3. The classification of lead as a Group B2 (probable human) carcinogen.

As discussed above, effects of concern have been associated with blood lead levels beginning at 10–15 ug/d1 in adults, children, and fetuses. Below 10 ug/dl, biochemical and other cellular level effects of questionable health significance have been reported. Therefore, for purposes of this regulation, EPA considers 10–15 ug/dl to be an appropriate range of concern for health effects that warrant avoidance.

Lead affects a wide range of organ systems; it can adversely affect the blood, the nervous system, normal growth and development, the kidneys, the reproductive system, and the cardiovascular system. An MCLG of zero is appropriate because there are no clearly discernable thresholds for some of these effects.

Another reason for setting the MCLG at zero is the fact that a portion of the population most sensitive to lead effects already has blood lead levels above the levels that pose a risk of causing some adverse effects. Although average blood lead levels are expected to be near 4–6 ug/dl in children in 1990 when this rule would take effect (EPA, 1988f), many individual children would still have PbB levels above 10 ug/dl (excluding children with lead paint/pica exposures, whose exposure from those sources overwhelms exposure from other sources), the lower bound of the range of concern. Because many children now have blood lead levels above the level of concern, EPA's policy goal is that drinking water contribute minimal additional lead to existing body burdens of lead.

Finally, EPA reviewed data on lead's potential carcinogenicity in determining the appropriate MCLG. Although difficulties in evaluating the dose-response data for lead prevent estimation of its carcinogenic potency, the data nonetheless clearly indicate that lead is carcinogenic in test animals. As explained by EPA in adopting MCLGs for other carcinogenic contaminants, the Agency does not believe that a threshold exists for carcinogenic effects (50 FR 46894, November 13, 1985). EPA therefore believes that, for carcinogens, zero is the level at which no known or anticipated effects occur with an adequate margin of safety, and EPA has established a policy of setting MCLGs at zero for compounds classified as Group A or B carcinogens. Setting the MCLG for lead at zero is consistent with that policy.

EPA has received a request from Multinational Business Services, Inc. ("MBS") to reconsider the Agency's policy of establishing MCLGs of zero for carcinogens and instead establish MCLGs for carcinogenic contaminants at calculated negligible risk levels. EPA considered adopting finite, risk-based MCLGs when it promulgated MCLGs for five carcinogenic volatile organic chemicals in (VOCs) 1985. EPA decided that, given the nonthreshold nature of carcinogenic effects, the zero MCLG option best fulfilled the mandate of the SDWA to establish MCLGs "at the level at which no known or anticipated adverse effects on the health of persons occur and which allows an adequate margin of safety." See 49 FR 24347–24348 (June 12, 1984) and 50 FR 46895–46896 (November 13, 1985). The Agency's decision to set MCLGs of zero for these five contaminants was upheld in *Natural Resources Defense Council* v. *Thomas,* 824 F.2d 1211 (D.C. Cir., 1987).

In its request, MBS contends that the recent decision by the U.S. Court of Appeals for the District of Columbia Circuit in *Natural Resources Defense Council* v. *EPA,* 824 F.2d 1146 (1987) ("*Vinyl Chloride*"), which construed the Agency's duties under section 112 of the Clean Air Act, applies to the establishment of MCLGs under the SDWA.

The Agency does not believe that the court's analysis in *Vinyl Chloride* must be applied to the setting of MCLGs. That decision construed the specific language of section 112 of the Clean Air Act and the legislative history of that provision. Section 1412 of the SDWA differs from section 112 of the Clean Air Act both in terms of its language and legislative history. Furthermore, the role of the MCLG as a non-enforceable health goal, the first step in the process of determining the enforceable MCL or treatment technique, is unique to the SDWA. In light of the distinctions between section 112 of the Clean Air Act and section 1412 of the SDWA, the Agency does not believe that following the *Vinyl Chloride* analysis in setting MCLGs is either necessary or appropriate. For these reasons, and the reasons described in the VOC rulemaking, EPA believes at this time that it is appropriate to set MCLGs for nonthreshold contaminants at zero. Nonetheless, the Agency has included the request submitted by Multinational Business Services in the record for this rulemaking, and the Agency intends to fully address that submission and any related comments when the Agency publishes the final MCLG for lead.

Public Comments: In 1985, a total of eight individuals and organizations commented on the proposed MCLG of 0.02 mg/l for lead. The public comments and EPA's responses are summarized below:

Comment Summary: Some commenters stated that the proposed MCLG of 0.02 mg/l for lead was appropriate. There was some disagreement among the commenters on whether an uncertainty factor of 5 or 10 (which would yield an MCLG of 0.01 mg/l) should be used.

EPA Response: For the reasons outlined above, EPA is now proposing an MCLG of zero for lead and so a discussion of what the safety factor would be is much less relevant than when a non-zero MCLG was proposed. The National Academy of Sciences and others suggest that a safety factor of 10 should be used when extrapolating from data obtained in human epidemiology studies to the general population. This was meant to address well-defined, known toxic endpoints. The endpoints in the case of lead exposure are extremely subtle enzymic and physiologic occurrences, and are not comparable to the traditional toxic endpoints. There is considerably less uncertainty about health effects from lead than from any other chemical. Excellent human data are available. Therefore, there is less need to apply the usual uncertainty factors in this case and a lower uncertainty factor is appropriate.

Comment Summary: Some commenters disagreed with the MCLG of 0.02 mg/l proposed for lead. One maintained that it has not been proven that low level lead exposure has adverse health effects and, therefore, the present level of 0.05 mg/l is fully protective and should not be decreased. Another commenter stated that since the primary sources of lead exposure are air and dust, available funds should be spent on reducing exposure from sources such as leaded gasoline and lead-based paint rather than drinking water, and cited a study by Morse et al. (1979) in support of the contention that drinking water lead does not increase blood lead levels.

EPA Response: EPA disagrees that low level lead exposure does not pose a health risk. The literature reviewed by this commenter is cursory and very selective, and only literature supportive of the commenter's perspective was included in the comment. EPA has reviewed and evaluated all relevant literature. In the November 1985 proposal, the Agency cited the Ryu et al. (1983) study as being the appropriate study to determine the effects of low level lead exposure on blood levels in infants, the most vulnerable subpopulation. In addition, EPA has reviewed further studies, discussed above, which also support the conclusion that there are adverse health risks at low level exposure levels.

EPA agrees that lead exposure from air, dust, and paint are important. These exposures are being addressed by other agencies such as the Department of Housing and Urban Development, and within EPA by other offices such as the Office of Air and Radiation (OAR). The study by Morse, et al. (1979) concluded that increased concentrations (over source water levels) of lead in soft, acidic drinking water are transported by distribution pipes. While the authors concluded that they could determine no level of drinking water lead that would increase blood lead levels, the data base was too small to produce statistically valid results. In addition, the average blood lead level in both the control group and the case group of children six years old and younger both exceeded 15 ug/dl. The blood lead levels of the one- and two-year-olds was >20 μg/dl. When blood lead levels are high, the relationship between blood lead and water lead appears to be relatively obscured by the higher body burden, in both the study and the control groups.

2. MCLG for Copper

EPA proposed an MCLG of 1.3 mg/l for copper in the November 1985 notice. As noted above, no new data that change the conclusions presented in that notice have become available since its publication. EPA is, therefore, reproposing an MCLG of 1.3 mg/l for copper.

The proposed MCLG of 1.3 mg/l for adults and children was based on a Lowest Observed Adverse Effect Level (LOAEL) of 5.3 mg/day from human clinical case studies in which 5.3 mg was the lowest acute oral dose at which gastrointestinal effects were seen (Chuttani et al., 1965). An uncertainty factor of two was applied, and daily consumption of 2 liters of water per day by an adult was assumed. Ten-day and longer exposure values were not derived because the data were inadequate.

Public Comments: Fourteen individuals and organizations commented on the MCLG proposed for copper in 1985. Several commenters agreed that it was reasonable to use short-term toxicity data as the basis for the proposed MCLG of 1.3 mg/l.

Several commenters thought that an MCLG for copper was unnecessary and that it would be more appropriate to issue a health advisory for the contaminant. The reasons included: (1) Inadequate adverse health effects data, (2) limited occurrence of copper in drinking water, and (3) the fact that copper is present in drinking water due to corrosion of copper pipes; thus, treatment at the water supply plant would not solve the problem of elevated copper concentrations.

EPA Response: EPA does not agree that there are inadequate health effects data for regulating copper. The data indicate that copper is a health risk at levels above 1.3 mg/l in water (although it is beneficial at lower levels); acute exposure to copper has resulted in gastrointestinal effects, such as nausea and diarrhea, as discussed in the 1985 proposal and above. EPA agrees that copper is not commonly found above the proposed MCLG, but high levels of copper have occasionally been detected in drinking water supplies across the country, and high levels of copper can leach from pipes in areas with corrosive water. Thus, EPA believes an MCLG and NPDWR are justified to protect against adverse health effects. In addition, Congress listed copper as one of 83 drinking water contaminants mandated for regulation in the 1986 amendments to the SDWA. Since EPA did not substitute another contaminant in place of copper (as authorized by section 1412(b)(2) of the SDWA), it remains on the list of 83 contaminants for which EPA must promulgate an MCLG and NPDWR.

IV. National Primary Drinking Water Regulations for Lead and Copper

A. Occurrence

1. Occurrence of Lead and Copper in Source Water and Distributed Water

a. *Lead.* There are several national surveys of lead occurrence in water leaving the treatment plant and entering the distribution system (distributed water). Well water drawn for drinking water generally has very low lead concentrations. In a national drinking water survey of nearly 1000 randomly chosen groundwater supplies completed in 1987 (the National Inorganics and Radionuclides Survey or NIRS), about 5 percent of the drinking water samples collected from fully flushed taps exceeded 0.005 mg/l of lead (EPA, 1988g). However, recent samples taken to determine the effect of the measurement point on estimates of lead in distributed water indicate that lead as a by-product of corrosion may enter fully flushed tap samples and be attributed erroneously to source water. Therefore, EPA resampled the supplies in NIRS that showed positive results for lead. EPA found very few samples above 0.005 mg/l of lead when the sampling point was moved to the entry point to the distribution system. Based on these new data, EPA estimates that approximately 90% groundwater

suppliers (or 1 percent of the community and non-transient, non-community water systems) may have water leaving the treatment plant that has greater than 0.005 mg/l lead (EPA 1988a).

A significant portion of the total lead present in surface waters exists as part of the suspended solids. This portion comes from natural soil lead augmented by atmospheric deposition and discharges by industrial and municipal discharges to surface water. The level of lead in water drawn from rivers and streams is slightly lower than the concentration found in groundwater. Eighty-six percent of the raw surface water samples analyzed by Fishman and Hems (1976) contained less than 0.010 mg/l of lead and less than 1 percent contained over 0.050 mg/l. However, the concentration of lead in distributed water from these sources may be much lower due to removal by treatment, e.g., sedimentation, prior to distribution.

The National Organic Monitoring Survey (NOMS, 1976) also provided data on the quality of fully flushed water from surface water supplies. The level of lead in the samples in this survey ranged from 1–10 μg/l.

Based on this information, EPA estimates that about 99 percent of the 219 million people in the United States using public water supplies (both surface and groundwater sources) are exposed to distributed water levels between 0 and 0.005 mg/l, and that about 2 million people are served by distributed water with levels of lead greater than 0.005 mg/l.

b. *Copper.* Copper levels above the proposed MCLG are rarely found in raw drinking water supplies or in distributed water. In the NIRS study (EPA, 1988g), which surveyed 983 randomly selected groundwater supplies, 85 percent of all fully flushed tap samples had copper levels below 0.06 mg/l; and 98 percent of such samples had copper levels below 0.46 mg/l. Less than 1 percent of the samples had copper levels above 1.0 mg/l. The maximum value found was 2.37 mg/l. In the 1969 Community Water Supply Survey (CWSS), samples were taken from 678 groundwater supplies, 109 surface water supplies, and 182 supplies of unknown or mixed origin (a total of 969 systems). For the groundwater supplies, the maximum copper level found was 0.47 mg/l and the mean of the positive measurements (i.e., those exceeding the detection limit of 0.1 μg/l) was 0.075 mg/l. For the surface water supplies, the maximum copper value found was 0.304 mg/l, and the mean of the positive measurements was 0.066 mg/l. EPA estimates that only 66 water suppliers would need to install treatment to lower copper levels to the MCLG (EPA, 1988a).

2. Occurrence of Lead and Copper as By-Products of Corrosion

a. *Lead.* Even when water leaving the water treatment plant is relatively lead-free, pipes, solder, and fixtures containing lead are corroded by water resulting in contamination of the water. Lead present in plumbing materials can be mobilized, resulting in significantly higher levels at the user's tap than in the water leaving the treatment plant. Three factors are particularly important in determining the degree of corrosion. First, the combination of copper pipes with solder containing lead found in most households can result in elevated lead levels due to galvanic corrosion. Galvanic corrosion is especially important in the case of newly-installed solder, which is particularly reactive. Therefore, people living in housing with lead-soldered plumbing less than five years old are at risk of having high levels of lead in drinking water. Second, the corrosivity of the water towards lead is a major factor influencing the occurrence of lead as a corrosion by-product. Third, regardless of age, water that has been in contact with lead pipe or solder for a period of time will contain higher lead levels than flushed water from the same pipe.

While the critical factors affecting lead levels in drinking water are well recognized, there are not sufficient quantitative data available to determine the national distribution of lead levels in drinking water at the tap in much detail. EPA has some morning first draw data, but these data were not collected in a systematic fashion and are therefore not nationally representative of lead levels at the tap. For example, of the 40 individual cities which collected and provided data to EPA, some targeted new housing or other high risk taps while others took random samples. In addition, certain geographic areas are severely under-represented. These data portray lead levels in cities with several water types, including both waters considered very corrosive towards lead and those considered to be relatively noncorrosive. Thus, these data are most useful for assessing the lead levels likely to occur under specific water quality conditions and with different plumbing materials. These systems have frequently measured levels of lead in morning first draw samples as high as 1–2 mg/l. A detailed presentation and analysis of these data appears in the Treatment and Occurrence Support Document (EPA, 1988h).

As described earlier, in the Patterson (1981) study, random daytime grab samples flushed for 30 seconds were collected and analyzed for lead. Flushing for 30 seconds will tend to result in samples with lower lead levels compared with levels that might be found in morning first draw samples and random daytime grab samples, because of the lower average standing time, tend to be lower also. The Patterson data are useful because of the large number of samples taken (782 samples), and because the geographic distribution of the samples was representative of the country (58 cities in 47 States were sampled). The percentage of samples collected from each State generally reflects the State population, except for California, which was slightly under-represented, and Illinois, which was somewhat over-represented. In the study, 60 percent of all samples were less than or equal to 0.010 mg/l, 84 percent were less than 0.020 mg/l, 97 percent were less than 0.050 mg/l, and 3 percent werer greater than or equal to 0.050 mg/l. (Information on lead levels below 0.010 mg/l are not available from this study, as the reported analytic detection limit was 0.010 mg/l.)

Because lead in tap water occurs primarily as a by-product of corrosion, the extent of moderately or highly corrosive water can give an indication of the potential extent of lead in tap water. The extent of corrosive water in the U.S. has been evaluated in several studies. The U.S. Geological Survey (USGS) (Durfor and Becker, 1964, as reported by EPA, 1986a) found that 17 States had very soft (corrosive) water (less than 60 mg/l as $CaCO_3$). The first National Health and Nutrition Examination Survey (NHANES I) was conducted by the National Center of Health Statistics (Greathouse and Osborne, 1980, as reported by EPA, 1986a). It showed similar results: about one-third of the country had very soft water (under 60 mg/l as $CaCO_3$). The American Water Works Association (AWWA) has estimated that about 66 percent of public water systems deliver water with pH<8 and/or carbonate alkalinity <30 mg/l (EPA, 1988a). Also, data reported by public water supplies to the States pursuant to 40 CFR § 141.42(d) indicate that as many as 80 percent of public water systems may deliver moderately or highly corrosive water, as indicated by pH <8 and/or alkalinity <30 mg/l (EPA, 1988i).

As explained above, lead levels in tap water can be particularly high when lead solder is less than five years old, due to galvanic action between lead solder and copper pipes (Oliphant, 1982 and 1983). A recent study by EPA (1986a) estimated the extent of housing

likely to contain lead solder particularly susceptible to galvanic corrosion by estimating the number of new houses in the U.S. Based on the number of new housing starts in 1983 and 1984, EPA estimated in 1986 that there were about 3.5 million new housing units less than 2 years old. About 8.1 million people were estimated to live in new homes served by public water supplies. Using the same method, the Agency now estimates that about 4.3 million homes are three to five years old and they house about 11 million poeple served by public water supplies.

b. *Copper.* Patterson (EPA, 1981) also measured copper levels in the 30-second partially flushed samples taken at random times during the day. In that study, 3 percent of the samples had copper levels exceeding 1 mg/l and 19 percent exceeded 0.2 mg/l. The national average was 0.221 mg/l (median=0.04 mg/l). The south central U.S. had the lowest average levels (average=0.82; median=0.02 mg/l), and the northeast had the highest average levels (average=0.526 mg/l; median=0.06 mg/l).

B. Regulatory Approach

In developing a regulatory approach for controlling lead and copper in drinking water, EPA was confronted with several problems. As described in the previous section, lead and copper differ in a very basic way from other drinking water contaminants because they generally do not occur in significant amounts in source water; rather, they generally enter the water in the distribution system from the corrosive action of the water in contact with plumbing materials containing lead and copper. Thus, the traditional regulatory approach, which is based on removing drinking water contaminants at the treatment plant prior to distribution, will have little or no effect on lead and copper levels at the consumer's tap (except for systems with lead and/or copper in their source water). Second, much of the lead- and copper-bearing plumbing material is privately owned (i.e., inside of buildings) and outside the public water system's control, which, in turn, restricts the regulatory options available, since national primary drinking water regulations only apply to public water systems.

Third, the occurrence of lead and copper contamination emanating from corrosion of plumbing systems within individual residences and other buildings introduces a wide source of potential variability among lead and copper levels that will be present in water samples taken at the tap. This problem makes it difficult for EPA to set uniform numbers, i.e., MCLs, for these contaminants that can be met at taps throughout a public water system.

Today's notice proposes a two-part approach to address the two sources of lead and copper in drinking water (corrosion of plumbing in the distribution system and source water contamination): A treatment technique requiring corrosion control to reduce leaching of lead and copper and public education to reduce exposure, and MCLs applicable to water entering the distribution system. This section explains EPA's rationale for this approach.

1. Treatment Technique Considerations

As explained earlier, the Safe Drinking Water Act, as amended in 1986, requires EPA to promulgate NPDWRs for 83 contaminants including lead and copper. Section 1412(b)(1). The Act does not distinguish between the two very different ways in which contaminants can enter drinking water: As by-products of corrosion versus occurrence in source water. The Act states that an NPDWR must contain an MCL or a treatment technique, and that EPA is authorized to promulgate a treatment technique in lieu of an MCL if it finds that it is not "economically or technologically feasible to ascertain the level of the contaminant." Sections 1401(1)(C) and 1412(b)(7)(A).

In developing the proposed regulation, EPA considered whether it was feasible to adequately monitor drinking water for the parameters of concern. Although it is feasible to measure accurately the amount of lead in a given water sample down to the practical quantitation limit (PQL), 0.005 mg/l (as described below), and copper down to the MCLG, these measurements alone bear little relation to the major issue of concern—the rate and extent of corrosion of lead and copper from plumbing materials.

As explained earlier, there can be considerable variability in lead and copper levels at the tap; even under constant water conditions (e.g., pH, alkalinity, temperature, and other parameters), there will be variability depending on the age and configuration of the building's plumbing. In addition, because water suppliers begin with different source waters, after corrosion control treatment to achieve particular levels of specified water quality parameters (e.g., pH = 8) lead and copper levels can still vary (assuming there is at least some of each of these metals in the plumbing system).

Generally, application of an effective treatment technology to remove contaminants will result in predictable contaminant levels in the finished water. Thus, measuring these levels will indicate whether treatment was effectively applied. For instance, application of reverse osmosis treatment to influent water with lead and copper levels in a specified range will reliably reduce the amount of lead and copper to certain levels; thus, measuring the effluent lead and copper levels will indicate whether the treatment was effective. In contrast, a single measurement of the lead or copper level at an individual tap is not a meaningful measure of the efficacy of any corrosion control treatment that is being applied because lead and copper levels at the tap can vary for reasons other than treatment effectivness. Since the resulting lead and copper levels will vary from system to system (and even from tap to tap within a system) after corrosion control treatment is applied, it is technologically infeasible to ascertain whether the lead or copper level at a tap at a single point in time represents effective application of the best available treatment technology, assuming BAT is optimal corrosion control treatment. The only way to tell whether a given system has optimized corrosion control treatment is to determine which specific water conditions, such as pH level, result in the lowest lead or copper levels for that system.

In conclusion, because of the variability of the occurrence of lead and copper within and among water systems, the Agency is unable to select a single level of lead or copper in drinking water that indicates whether a system has implemented optimal corrosion control treatment. Unfortunately, there is no known reliable index or measure of water corrosivity towards lead and copper plumbing materials either. Therefore, EPA is proposing treatment technique requirements to control lead and copper as corrosion by-products.

2. Problems with Setting an MCL at the Tap

EPA considered whether it could set MCLs at the tap for lead and copper that were based on optimal corrosion control treatment, as well as removal of lead and copper from source water at the treatment plant. Under section 1412(b)(4) of the Act, the MCL must be set as close to the MCLG as feasible. "Feasible" means "feasible with the use of the best technology, treatment techniques and other means which the administrator finds * * * are available (taking cost into consideration)" (BAT). Section 1412(b)(5). Thus, in setting MCLs for lead and copper based on optimal

corrosion control treatment, EPA would have to determine what levels of these contaminants are "feasible" to achieve using this technology. In considering what levels are feasible to achieve, EPA must consider the range of conditions a public water system faces. Some customers may have plumbing containing only small amounts of lead and copper (so leaching is less likely), while others may have plumbing that contains large amounts of lead, possibly as new lead solder (so leaching is more likely).

In determining what is feasible, EPA also must consider the extent of the public water system's responsibility under the Safe Drinking Water Act for contaminant levels at the tap, especially for contaminants entering the water from the distribution system after any treatment, i.e., corrosion by-products. Under section 1411, NPDWRs apply to "public water systems." Section 1401(4) defines "public water system" as:

> A system for the provision to the public of piped water for human consumption * * *. Such term includes (A) any collection, treatment, storage, and distribution facilities under control of the operator of such system * * * and (B) any collection or pretreatment storage facilities not under such control * * *.

It is important to note that this definition clearly distinguishes between facilities under the system's control and facilities that are not. Furthermore, the term "public water system" specifically includes "distribution facilities under control of the operator of such system"; yet "distribution facilities" are not listed among the facilities *not* under the system's control that are nonetheless included in the definition of public water system. Thus, it appears that while Congress included distribution systems within the public water system's control, it deliberately excluded distribution facilities not under the system's control, e.g., customers' plumbing, from the definition of "public water system." EPA believes this provision precludes the Agency from promulgating an NPDWR that holds a public water system liable for conditions in the parts of the distribution system that are outside its control. This is a reasonable interpretation since the public water system does not generally have control over these facilities and thus should not be held responsible for them.

Because the public water system is not responsible for distribution facilities outside its control, the question arises as to what MCLs based on corrosion control are feasible for lead and copper given that the standard must take into account the range of conditions occurring in these facilities, i.e., in customers' plumbing. In other words, in setting MCLs for lead and copper based on optimal corrosion control treatment (and any necessary technology to remove lead and/or copper in the source water), EPA would have to select levels that are feasible for large public water systems to meet, regardless of the type and age of the plumbing in its customers' homes; any more stringent MCL would hold the system liable for a violation caused by distribution facilities outside its control, which would be inconsistent with the Act's definition of public water system.

In reviewing the data available, it appears that any MCL for lead at the tap that would be feasible, i.e., achievable by systems that have installed the best available technology (assuming BAT consists of some technology that removes any lead in the source water and optimal corrosion control treatment), regardless of the condition of its customers' plumbing, would be relatively high, perhaps a maximum of 0.030–0.040 mg/l in single samples of morning first draw water, or an average of 0.015–0.020 mg/l in morning first draw samples. EPA believes these levels represent unnecessarily high exposures for large segments of the population.

It has been suggested that, rather than selecting an MCL that systems could meet regardless of homeowner plumbing, EPA should set a more stringent MCL and make variances available for systems that cannot meet it because of homeowner plumbing. Under section 1415 of the Act, variances are available to systems which cannot meet an MCL "because of characteristics of the raw water sources which are reasonably available to the systems." EPA believes Congress intended that variances should be available when levels of the regulated contaminant were so high in the source water that BAT could not remove sufficient quantities to meet the MCL, or when some other characteristic of the source water prevented the best available technology from achieving the MCL. In the case of corrosion by-products such as lead and copper, any exceedence of an MCL at the tap after application of BAT (assuming it consists of technology to remove these contaminants in the source water and installation of optimal corrosion control treatment) would not be the result of extraordinary levels of the contaminant in the source water. Rather, the exceedence would be due to the addition of lead and/or copper from leaching of materials in the distribution system including plumbing in individual houses. This rules out the first basis for the variance, i.e., levels too high for effective removal by BAT. Arguably, however, a system could get a variance on the second basis, i.e., because the nature of its raw water source is such that, even after installation of BAT (assuming BAT consists of a technology to remove any lead and/or copper in the source water and optimal corrosion control treatment), the system could not meet the MCL. At least three problems arise with this approach, however.

The first problem is that variances are temporary in nature; section 1415 assumes eventual compliance with the standard when a variance is granted. This section specifically requires that every variance be accompanied by a schedule for coming into compliance; this schedule must require compliance "as expeditiously as practicable." However, it is likely that, in cases where the MCL violation is a result of corrosion of private plumbing, there will not be sufficient measures that a public water system can take unilaterally to achieve compliance. Thus, no reasonable compliance plan (much less a schedule for implementing it) could be devised. The second problem is that many, if not all, systems would require variances because at least a few, if not many, buildings served by them are likely to have lead and/or copper plumbing that are not under the water supplier's control. The Agency does not believe it makes sense to promulgate an MCL that many systems not only cannot meet now, but also could not meet at some future time. Furthermore, the Act requires that an MCL must be feasible. In determining what is feasible, the legislative history of both the Safe Drinking Water Act of 1974 and the 1986 amendments indicates that EPA is to consider whether the technology is reasonably affordable by regional and large metropolitan public water systems (see H.R. Rep. No. 93–1185, p. 18 (1974) and statement of Senator Durenberger, 132, *Cong. Rec.* S6287 (daily ed., May 12, 1986)). Large systems are not less likely than smaller systems to serve homes with lead and/or copper plumbing; in fact, they are probably more likely to serve at least some such homes since they serve so many customers. EPA believes that an MCL that most large systems (as well as many small systems) cannot meet when they install BAT is not feasible under the Act. The third problem is that a system qualifies for a variance under section 1415 only if operation under the variance will not result in an unreasonable risk to health. Assuming there is some lead level(s) and some copper level(s) which represent an unreasonable risk to health, then any system exceeding these

levels would not qualify for a variance. Thus, the systems that "need" the variance the most (i.e., those least capable of meeting the MCL because they are the furthest from compliance) would not qualify for it.

Despite these considerations, some interested parties nonetheless have indicated that they believe MCLs at the tap are appropriate for regulating lead and copper. EPA solicits comments on the details of such a regulation, including suggestions on overcoming the difficulties associated with an MCL approach that are described above. Specifically, commenters should specify the appropriate MCL and the basis for selecting this value, what monitoring requirements should apply (e.g., whether the NPDWR should allow systems to avoid monitoring at residences with high lead and/or copper content in their household plumbing), and whether systems that have installed BAT and still cannot meet the MCL because of private plumbing should be considered permanently out of compliance (and thus subject indefinitely to public notification requirements and citizen suit enforcement actions to compel compliance).

3. MCLs Applicable to Water Entering the Distribution System

While EPA recognizes that most of the lead and copper found in drinking water from the tap is added by plumbing after the water leaves the treatment plant, as described above, in an estimated one percent of the systems, lead and/or copper may occur at high levels in the source water. Therefore, EPA evaluted the feasibility of establishing MCLs for lead and copper in distributed water, i.e., MCLs that would apply, and for which compliance could be monitored as the water enters the distribution system, after any treatment. Such MCLs would not be subject to the problems associated with establishing MCLs to control contributions of lead and copper due to corrosion and monitoring for compliance with such MCLs. These MCLs would reduce total lead and copper levels by removing these contaminants when they occur in source water.

4. Summary of Proposed Regulatory Approach

In conclusion, most of the lead and copper found in drinking water at the tap is added by plumbing after the water leaves the treatment plant. In a few systems, lead and/or copper may occur at high levels in the source water. Therefore, the most important step a public water system can take to control lead and copper levels at the tap is to install optimal corrosion control treatment. However, it is technically infeasible to set MCLs at the tap for these contaminants because no single lead or copper measurement, or any other water parameter, indicates whether treatment was effectively applied, i.e., corrosion control treatment has been optimized. Consequently, in this rule, EPA is proposing an NPDWR consisting of a treatment technique requirement that would require optimal corrosion control treatment. In addition, this MPDWR would require public education when lead levels exceed certain values even after optimal corrosion control treatment.

In addition, the Agency is proposing MCLs for lead and copper that would apply to water leaving the drinking water treatment plant (if the water is treated) and entering the distribution system. By limiting lead and copper in distributed water, this proposal would result in contaminant levels closer to the MCLGs than would be possible with the treatment technique rule alone. Together, these three NPDWRs (one for lead and copper as corrosion by-products, one for lead in source water, and one for copper in source water) would address the contamination of drinking water by lead and copper.

Today's proposal would fulfill the goal of the SDWA by requiring an important reduction in the levels of lead and copper present in consumers' water. EPA believes the resulting lead and copper levels would be as close to the MCLG as is feasible. In addition, EPA believes that these proposed NPDWRs (establishing "no-action levels" of an average lead level of 0.010 mg/l lead, 1.3 mg/l or less copper in 95 percent or more samples, and pH >8 in 95 percent or more samples to trigger treatment, and a no-action level of an average of 0.010 mg/l lead and 0.020 mg/l or less lead in 95 percent or more samples to trigger public education) would be protective of public health. The Agency expects that implementation of this proposal would result in large reductions in the number of people who experience blood lead levels above the range of concern of 10–15 ug/dl, and above 25 ug/dl, the level above which CDC recommends medical intervention. Section X.A of this notice presents estimates of the benefits associated with the proposal.

C. Treatment for Lead and Copper in Source Water

EPA evaluated technologies for treatment of lead and copper in source water to determine which are BAT. Table 1 summarizes the technologies identified by EPA for the removal of these drinking water contaminants. Table 2 lists the removal efficiencies that are attainable through the use of the identified technologies. Examination of these technologies indicates that they are capable of reducing contaminant levels from the maximum levels of occurrence in source water to the proposed MCLG for copper and down to 0.005 mg/l for lead. Table 3 shows the removal efficiencies that would be required of treatment technologies to reduce the maximum expected influent concentrations down to 1.3 mg/l for copper and 0.005 mg/l for lead (listed as "MCL-Effluent Concentration" in the table. The influent concentrations assumed correspond to maximum observed occurrence levels in drinking water sources.

TABLE 1.—CANDIDATE BEST AVAILABLE TECHNOLOGIES (BATS) FOR THE REMOVAL OF LEAD AND COPPER FROM DRINKING WATER SUPPLIES

Contaminant	Technologies			
	Coagulation/ Filtration	Ion exchange	Lime softening	Reverse osmosis
Lead	X	X	X	X
Copper	X	X	X	X

TABLE 2.—REMOVAL EFFICIENCIES OF CANDIDATE BATS[1,2]

[in percent]

Contaminant	Technologies (percent removal)			
	Coagulation/Filtration	Ion exchange	Lime softening	Reverse osmosis
Lead	80-99	up to 95	97-99	90-99
Copper	60-95	up to 95	90-96	90-99

[1] *Source:* "Technologies and Costs for the Removal of lead from Potable Water Supplies." Office of Drinking Water, October 23, 1984. Revised Final Draft.
[2] *Source:* "Technologies and Costs for the Removal of Copper from Potable Water Supplies." Office of Drinking Water, June 15, 1985. First Draft.

TABLE 3.—REMOVAL EFFICIENCIES NECESSARY TO ACHIEVE SPECIFIED EFFLUENT CONCENTRATIONS

Contaminant	Occurrence-influent concentration	MCL—effluent concentration	Percent removal required to achieve Proposed MCL
Lead	0.100 mg/l	0.005 mg/l	95
Copper	10 mg/l	1.3 mg/l	87

The costs for the removal of these contaminants, assuming the same influent and effluent levels cited in Table 3, using various technologies, are summarized in Tables 4, 5, 6, and 7. The general assumptions used to develop the treatment costs include: Late 1986 chemical costs, capital costs amortized over 20 years at a 10 percent interest rate, late 1986 engineering fees, contractor overhead and profit, and late 1986 power and fuel costs and labor rates.

TABLE 4.—SAMPLE ESTIMATED COSTS OF REMOVAL OF CONTAMINANTS FROM SOURCE WATER BY VARIOUS TECHNOLOGIES INCLUDING WASTE DISPOSAL COST [1]

[cents/1,000 gallons, 1986 dollars]

Contaminant/technology	Population served				
	25-100	500-1000	1001-3300	3301-10,000	>1,000,000
Lead					
Ion exchange	270	100	74	69	32
Reverse osmosis	620	320	260	220	160
Lime softening	.....	220	140	100	68
Coagulation/Filtration	.....	160	91	90	24
Copper					
Ion exchange	250	94	87	60	30
Reverse osmosis	540	300	230	190	140
Lime softening	.....	43	21	9	1
Coagulation/Filtration	.....	160	90	82	23

[1] Costs derived from: "Cost Supplement to Technologies and Costs for the Removal of Lead from Potable Water Supplies." ODW. Jan. 19, 1987. First Draft; "Cost Supplement to Technologies and Costs for the Removal of Copper from Potable Water Supplies." ODW. Jan. 19, 1987. First Draft; and "Technologies and Costs for the Treatment and Disposal of Waste By-Products from Water Treatments for the Removal of Inorganic and Radioactive Contaminants." ODW. Sept. 23, 1986. Revised Draft.

TABLE 5.—SAMPLE ESTIMATED CAPITAL COSTS FOR REMOVAL OF LEAD AND COPPER [1] BY VARIOUS TECHNOLOGIES FOR SELECTED SYSTEM SIZE CATEGORIES

[millions 1986 dollars]

Contaminant/technology	Population served		
	25-100	3300-10,000	>1,000,000
Lead			
Ion exchange	0.09	1.4	170
Reverse osmosis	0.13	4.8	1,140
Lime softening	.....	1.4	310
Coagulation/Filtration	0.17	3.0	360
Copper			
Ion exchange	0.09	1.3	160
Reverse osmosis	0.11	3.4	1,060
Lime softening	.....	0.23	1.3
Coagulation/Filtration	0.20	2.3	340

[1] Costs derived from: "Cost Supplement to Technologies and Costs for the Removal of Lead from Potable Water Supplies." ODW. Jan. 19, 1987. First Draft; "Cost Supplement to Technologies and Costs for the Removal of Copper from Potable Water Supplies." ODW. Jan. 19, 1987. First Draft; and "Technologies and Costs for the Treatment and Disposal of Waste By-Products from Water Treatments for the Removal of Inorganic and Radioactive Contaminants." ODW. Sept. 23, 1986. Revised Draft.

TABLE 6.—SAMPLE ESTIMATED ANNUAL INCREASE IN HOUSEHOLD WATER BILLS DUE TO APPLICATION OF BATs FOR REMOVAL OF LEAD AND COPPER REMOVAL [1] FOR SELECTED SYSTEM SIZE CATEGORIES

[dollars household/yr; 1986 dollars]

Contaminant/technology	Population served		
	25–100	3,300–10,000	>1,000,000
Lead:			
Ion exchange	270	[illegible]	32
Reverse osmosis	[illegible]	220	160
Lime softening	.....	180	[illegible]
Coagulation/Filtration	.....	12	2
Copper:			
Ion exchange	250	60	30
Reverse osmosis	540	190	140
Lime softening	.....	[illegible]	1
Coagulation/Filtration	.....	[illegible]	23

[1] Cost derived from: "Cost Supplement to Technologies and Costs for the Removal of Lead from Potable Water Supplies." ODW. Jan. 19, 1987. First Draft; "Cost Supplement to Technologies and Costs for the Removal of Copper from Potable Water Supplies." ODW. Jan. 19, 1987. First Draft; and "Technologies and Costs for the Treatment and Disposal of Waste By-Products from Water Treatments for the Removal of Inorganic and Radioactive Contaminants." ODW. Sept. 23, 1986. Revised Draft.

TABLE 7.—WASTE BY-PRODUCT DISPOSAL COSTS FOR PUBLIC WATER SYSTEMS—ALTERNATIVES WITH LOWEST COST [1]

[cents/1,000 gallons drinking water produced; 1986 dollars]

Contaminant/Technology	Population	25–100	101–500	501–1000	1001–3300	3301–10K	1,000,000
	Flow (MGD)	0.013	0.004	0.1333	0.40	1.30	650
Sludges:							
Lime softening							
Dewatering and land disposal [2]	550	[illegible]	120	[illegible]	60	40	
Land application	1200	[illegible]	150	[illegible]	50	[illegible]	
Coagulation/filtration							
Sanitary sewer discharge							
—Copper	[illegible]	62	[illegible]	15	[illegible]	[illegible]	
—Lead	[illegible]	[illegible]	22	10	[illegible]	0	
Dewatering and land disposal [2]	[illegible]	120	55	[illegible]	[illegible]	7	
Brines:							
Ion exchange							
Discharge to POTW [3]	[illegible]	71	[illegible]	[illegible]	12	[illegible]	
Reverse osmosis							
Direct discharge	85	[illegible]	[illegible]	11	[illegible]	0	
Discharge to POTW	220	150	[illegible]	47	27	10	

[1] Draft, "Technologies and Cost for the Treatment and Disposal of Waste By-products from Water Treatments for the Removal of Inorganic and Radioactive Contaminants." ODW. Sept. 23, 1986. Revised Draft.
[2] Dewatering by nonmechanical methods, e.g., lagoons and drying beds.
[3] Publicly owned treatment works.

Costs for individual plants may vary from those shown, depending on local circumstances. However, based on available information, the costs in Tables 4–7 are representative of typical system costs using these technologies. Two different models have been used to calculate the costs in Tables 4–7. A small system cost model has been used for systems that serve less than 3,300 people. This model assumes that a package treatment plant would be installed to treat the water. The model used for systems serving more than 3,300 people assumes that the treatment plant would be built in the field.

Costs of treatment will be less than shown in Tables 4, 5, 6, and 7 if contaminant concentration levels encountered in the raw water are lower than the maximum occurrence levels used for the supporting calculations. EPA expects this to be the case in most instances. For example, if the contaminant level in the raw water is half of the maximum occurrence level, then treatment costs could be expected to be approximately 20 to 50 percent lower than the costs presented. However, costs of treatment could be higher if, for instance, there are additional site-specific treatment or storage requirements. The various removal technologies considered are described in more detail below.

1. Ion Exchange

This notice proposes to designate sodium cation exchange to remove lead and copper as BAT because of its demonstrated ability to reduce levels of lead and copper to 0.005 mg/l for lead and to the proposed MCLG for copper, at reasonable costs. Sodium cation exchange resins and ion exchange equipment are readily available commercially. Sodium cation exchange has been successfully used in the field, and pilot plant studies demonstrate that this technology can be used to remove up to 95 percent of lead and up to 95 percent of copper from water. Ion exchange treatment can be implemented effectively for all sizes of treatment facilities. The cost of employing ion exchange for removal of lead and copper in drinking water has been estimated for source water lead concentrations of 0.100 mg/l and source water copper concentrations of 10 mg/l and are included in Tables 4, 5, 6, and 7. Blending can significantly reduce ion exchange equipment requirements and

operating costs, since then only a portion of the raw water has to be treated. Ion exchange is adversely affected by the presence of turbidity, iron, and organic contaminants. Pretreatment may therefore be necessary in some cases. Also, ion exchange can soften water, making it more corrosive, especially if calcium breakthrough is used as the indicator for resin regeneration.

2. Reverse Osmosis

EPA also is proposing to designate reverse osmosis (RO) technology as BAT because it has been demonstrated to be effective in removing lead and copper at reasonable costs. RO has been widely used on a full scale basis for the reduction of other contaminants, and pilot plant studies demonstrate that this technology is capable of removing 95 percent of lead (when source water lead is 0.100 mg/l) and 95 percent of copper (when source water copper is 10 mg/l) from drinking water. The costs of employing RO to reduce these contaminants from these levels in drinking water are presented in Tables 4, 5, 6, and 7. A major disadvantage of RO is that in removing dissolved solids from water, and thereby softening it, RO makes the water more corrosive toward lead and copper in plumbing. Thus, source water treated by this process would require subsequent corrosion control treatment to raise pH and stabilize the water before distribution.

RO performance is adversely affected by the presence of turbidity, iron, manganese, silica, or scale-producing constituents in source water. If pretreatment is not already in place to remove these constituents, the cost to install the pretreatment technologies (e.g., pH adjustment, filtration, application of scale prevention additives) may be considerable.

In the case of contamination of source water by several contaminants, in addition to lead and/or copper, the RO process may offer an especially desirable and cost effective approach to their removal. Blending can reduce costs, as only a portion of the water may need to be treated.

3. Lime Softening

Lime softening can achieve 97 to 99 percent removal of lead at pH levels of 9.0 to 10.5 and 90 to 96 percent removal of copper at pH levels of 9.0 to 11.5, as indicated by laboratory and pilot plant studies. This technology is considered BAT because it has been demonstrated to reduce lead and copper in water to 0.005 mg/l for lead and the proposed MCLG for copper at reasonable costs. Lime softening has been widely and effectively used on a full scale basis for the reduction of hardness. The costs of installing new lime softening facilities to reduce contaminant concentrations in drinking water from 0.10 mg/l to 0.005 mg/l for lead and 10 mg/l the MCLG for copper are shown in Tables 4, 5, 6, and 7. One advantage of lime softening is that it increases the pH of the water and thus reduces its corrosivity.

4. Coagulation/Filtration

EPA is proposing coagulation/filtration technology as BAT for lead and copper removal because of its demonstrated ability to reduce levels of lead and copper to the proposed MCLG for copper and 0.005 mg/l for lead at reasonable costs.

Laboratory and pilot plant studies indicate that conventional coagulation/filtration using alum, and in some cases, ferric sulfate coagulant, can achieve 80 to 95 percent removal of lead at pH levels of 8.0 or above, and can achieve 60 to 95 percent removal of copper at these same pHs. Removal efficiencies are estimated based on source water lead levels of 0.10 mg/l and copper of 10 mg/l. Published studies (EPA, 1978) suggest that site-specific raw water quality indicators, such as pH, significantly affect the removal efficiency of alum when used to treat ground water. However, data are not available which specifically identify all optimum operating conditions of coagulation/filtration treatment for lead and copper removal.

Coagulation/filtration is very effective when ferric sulfate is used as the coagulant. In pilot-scale studies, greater than 95 percent removals have been achieved using this coagulant. When alum is used as the coagulant in doses above 20 mg/l, removal efficiencies of 95 percent have been achieved in surface water. For ground water, either much larger alum doses or pH adjustment is required to achieve 95 percent removal of lead. Coagulation/filtration has been used on a full scale basis for the reduction of other contaminants in water, including turbidity, particulate matter, and microbial contaminants (EPA, 1978). Estimated costs to reduce lead and copper using conventional coagulation/filtration are shown in Tables 4, 5, 6, and 7.

5. Selection of BAT

In conclusion, the Agency believes that, of the technologies that can remove lead and copper from source water, ion exchange, reverse osmosis, lime softening, and coagulation/filtration fulfill the requirements of the SDWA as BAT for lead and copper in source water. These treatment technologies have high efficiencies for lead and copper removal from source water, and the cost of these technologies for large public water systems is reasonable. Under the Act, other treatment technologies could be used to remove lead or copper. However, a system would be required to install one of the BATs in order to be eligible for a variance from the MCL.

All of the technologies proposed as BAT are currently available, have been installed in public water systems, and are compatible with other water treatment processes in different regions of the U.S. Furthermore, these technologies are available and effective for the reduction of these contaminants from the maximum levels of occurrence in source water to 0.005 mg/l for lead and to the proposed MCLG level for copper (1.3 mg/l).

D. Treatment for Lead and Copper as Corrosion By-products

1. Corrosion Control

All water is corrosive to metallic plumbing materials to some degree; the relative corrosivity of a given water supply depends on a variety of factors. There is no single corrosivity index that can predict water corrosivity to lead and copper, and the water of each water supplier may be minimally corrosive to these metals under slightly different finished water quality conditions.

The degree of water corrosivity toward lead and copper plumbing materials depends largely on the pH and alkalinity of the water, although a number of additional factors, such as temperature, flow rate, free chlorine levels, age of plumbing materials, and other factors are important as well. While the use of specific plumbing materials in buildings is not under the control of water suppliers, water chemistry parameters are. Therefore, adjustment of water quality parameters, especially pH and alkalinity, to minimally corrosive ranges and addition of corrosion inhibitors are the primary methods of corrosion control treatment available to public water systems to minimize lead and copper levels.

The corrosivity of acidic water toward lead plumbing materials is well documented (EPA, 1982; Hoyt et al., 1979; O'Brien et al., 1976; Lyon and Lenihan, 1977; Gregory and Jackson, 1984). Water with pH below 8.0, and especially below 7.0, tends to be more corrosive toward lead and copper than water with pH greater than 8.0, and more corrosive water tends to produce water samples with higher lead and copper levels.

The alkalinity of water, which is related to pH, is also an important factor in determining its corrosivity and, in turn, its likelihood of producing high lead and copper levels at the tap. Water contains alkalinity in several forms, including carbonate ion, bicarbonate ion, and hydroxyl ion, in equilibrium. The pH of the water largely determines which of these species predominates in the equilibrium. At pHs less than 8.3, equilibrium favors the bicarbonate form. At pHs between 8.3 and 10, equilibrium tends toward the carbonate form, and pHs above 10 favor hydroxyl.

Under certain chemical conditions (especially high pH), the carbonate in water will react with lead in the plumbing to form a film of basic lead carbonate or other relatively insoluble salt on the interior surface of the pipes and solder. This film isolates the lead metal from the water and thus slows the rate at which lead from the pipes or solder is dissolved into the water. Carbonate also limits the amount of lead the water will hold in solution.

Depending on the raw water quality, treating the water to minimize its corrosivity may require the adjustment of pH and alkalinity, individually or simultaneously. Experience in field and laboratory studies indicates that stabilization of the water can reduce corrosion and reduce levels of lead substantially (EPA, 1982; Karalekas et al., 1983; Karalekas et al., 1978; EPA, 1988h). In addition, the presence of carbonate is an important factor in stabilizing the pH of the water because it adds buffering capacity. Without the buffering capacity imparted by the carbonate water pH can decrease as it moves through the distribution system.

There are also other methods for a water supplier to reduce the corrosivity of its water. These include the use of corrosion inhibitors, such as orthophosphates, and the adjustment of free chlorine levels (EPA, 1987c). Sodium hexametaphosphate has also been used as a corrosion inhibitor, as have other chemicals, although they may not be as effective as orthophosphates.

The rate of copper corrosion is also dependent on pH. However, alkalinity appears to be a less important factor than in copper corrosion than lead corrosion. Corrosion of copper pipe is rapidly accelerated at pHs below 5.0; morning first draw samples at pHs less than 5.5 will likely exceed 1.0 mg/l. The copper concentrations will increase with decreasing pH, increasing temperature, and decreasing age of copper pipe. As pH is increased to 8.0 and above, the rate of copper corrosion is reduced. The chemical behavior of copper and lead are similar so that most treatments (such as pH and alkalinity adjustment) to lower the solubility of lead will have a similar effect on copper. For instance, the pH level for effective lead corrosion control is 8.0 or greater, and this is also an appropriate pH for control of copper corrosion. Therefore, EPA has determined that properly applied corrosion control for lead will also adequately control copper concentrations (AWWARF, 1985).

a. *Methods of pH Adjustment.* Adjustment of pH is one of the most common methods of reducing corrosion in water distribution systems. In many instances, if sufficient alkalinity is present, pH adjustment is adequate to control the corrosivity of water.

The least expensive and most commonly used chemical for pH adjustment is sodium hydroxide (NaOH, or caustic soda); potassium hydroxide may also be used in water with high sodium levels. Lime (especially in the form of calcium carbonate slurry) addition is also used commonly for pH adjustment. Experience in field, pilot plant, and laboratory tests indicates that a substantial reduction of lead and copper in drinking water may be achieved by pH adjustment. Estimated costs for pH adjustment using sodium hydroxide to control corrosion of lead and copper range from $0.67/1,000 gallons for systems serving less than 100 persons to $0.03/1,000 gallons for systems serving more than 1,000,000 persons. Estimated costs for pH adjustment using lime to control corrosion of lead and copper range from $0.85/1,000 gallons for systems serving fewer than 100 persons to $0.006/1,000 gallons for systems serving more than 1,000,000 persons (EPA, 1988h).

The Metropolitan Regional Water Authority (MRWA), which supplies water to Boston, Massachusetts, and surrounding communities, has implemented corrosion control by pH adjustment. (The MRWA used to be called the Metropolitan District Commission, or MDC.) The raw water is low in hardness, alkalinity, total dissolved solids, and pH. Prior to the start of corrosion control, treatment consisted of chlorination and ammoniation only.

The treatment program implemented by MRWA consists of adding 14 mg/l of caustic (50 percent NaOH) to treat 300 million gallons/day (MGD). The pH of the finished water is increased to 8.5 at the reservoir after treatment but before distribution. The alkalinity of the finished water is only slightly increased as a result of this treatment.

Samples were collected in from twelve to fourteen homes served by MRWA over a period of five years. The homes selected for the sampling program have lead service lines. Three samples were taken at each location representing first draw water (i.e., water in the interior plumbing), water from the service line, and water in the main (i.e., fully flushed water). The goal of the program was to reduce most samples to less than 0.050 mg/l. Since the sampling program began before the implementation of the corrosion control treatment, the effectiveness of this treatment toward its goal can be evaluated.

The results of this analysis have been published (Karalekas et al., 1983). In this article, the data from the fourteen locations were evaluated differently from the approach EPA is proposing in this rule for determining compliance. However, the effectiveness of the treatment in reducing lead levels can still be evaluated from the data. In this article, the results of all three samples from all locations sampled were averaged. The average lead concentration ranged from 0.060 mg/l to 0.128 mg/l between February 1976 and May 1977, before the use of NaOH to adjust pH began. The average lead concentration dropped substantially after the start of this treatment; except during two interruptions in the pH adjustment treatment, the average lead concentration was reduced consistently to below 0.050 mg/l (ranging from 0.010 mg/l to 0.050 mg/l), MRWA's target lead concentration.

In addition, the City of Seattle, Washington, has adjusted the pH of its Cedar River supply in an effort to control corrosion (EPA, 1988h). The treatment program implemented by Seattle in 1983 consists of adding 2 mg/l of lime as CaO to adjust the pH from 7.5 to 8.2. The total alkalinity in the raw water varies seasonally from 16.3 mg/l to 23 mg/l as $CaCO_3$.

Sampling to determine the extent of the problem began in 1979 and is still ongoing. Two samples are taken at each location. The first sample is a standing sample (not morning first draw) and the second sample is a flushed sample. The mean lead concentration for the Cedar River supply standing samples dropped from 0.0103 mg/l to 0.0038 mg/l after treatment. The percentage of standing samples with lead concentrations less than 0.010 mg/l rose from only 50 percent before treatment of 93.8 percent after treatment.

These data demonstrate that adjustment of pH can effectively reduce the corrosivity of water towards lead in interior plumbing and can greatly reduce the levels of lead in tap water.

b. *Methods of Alkalinity Adjustment.* For waters that are low in carbonate or bicarbonate alkalinity, pH adjustment alone is often insufficient to control corrosion because there are insufficient carbonate ions in the water to form a protective layer on the interior surface of the pipes or lead solder. In these low alkalinity waters, carbonate ion must be added to form the insoluble carbonates. Soda ash (Na_2CO_3) or sodium bicarbonate ($NaHCO_3$) is typically added for this purpose.

Lime (calcium oxide slurry) or sodium hydroxide, in conjunction with soda ash (sodium carbonate) and sodium bicarbonate, may be used together to adjust pH and carbonate alkalinity simultaneously. These methods are cost-effective and are practiced by many water suppliers already. Estimated costs for treating the water using these chemicals range from $1.49/1,000 gallons for systems serving 25 to 100 persons to $0.08/1,000 gallons for systems serving more than 1,000,000 persons (EPA, 1988h).

A program to control corrosion combining pH and alkalinity adjustment was implemented by the City of Bennington, Vermont, on its water supply in August 1977. The treatment program consists of adding 3 mg/l of sodium hydroxide to adjust the pH from 5.0 to 7.2 and 10 mg/l of sodium bicarbonate to adjust the alkalinity from less than 1 mg/l to 15 mg/l as $CaCO_3$. The goal of the program was to reduce average lead levels to less than 0.050 mg/l. Samples were collected periodically from nine to eleven homes from April 1977 to November 1980. Three samples were taken at each location, representing first draw water (i.e., water in the interior plumbing), water in the service line, and water in the main (i.e., fully flushed water). The mean lead concentration for the first flush samples was reduced from 0.101 mg/l to 0.0342 mg/l as a result of the treatment. The mean lead concentration in the service line samples was reduced from 0.184 mg/l to 0.0302 mg/l and the mean lead concentration in the fully flushed samples was reduced from 0.102 mg/l to 0.0167 mg/l as a result of this treatment. In addition, the number of samples with lead concentrations less than 0.010 mg/l increased as a result of the corrosion control treatment. While only 2.6 percent of the first flush samples contained less than 0.010 mg/l lead before treatment, after treatment was implemented, 20.9 percent of the first flush samples contained less than 0.010 mg/l lead (EPA, 1988h).

In 1983, the City of Seattle, Washington began adjusting pH and alkalinity of its Tolt River supply. The treatment program consists of adding 2 mg/l of lime as CaO to adjust the pH from 6.2 to 8.2 and 9 mg/l of sodium carbonate as Na_2CO_3 to adjust the total alkalinity from 4 to 12 mg/l as $CaCO_3$.

The study of the Tolt River supply was conducted at the same time as the study on Seattle's Cedar River supply, and the sampling procedure was the same as described in the discussion of the Cedar water supply above. The mean lead concentration for the standing samples from the Tolt River supply dropped from 0.0102 mg/l before treatment to 0.0041 mg/l after treatment. The percentage of standing samples with lead concentrations less than 0.010 mg/l increased as a result of treatment from 50 to 90.3 percent (EPA, 1988h).

These data show that increasing pH and alkalinity within appropriate concentration limits can effectively reduce the corrosivity of water towards lead in interior plumbing and greatly reduce the levels of lead in tap water.

c. *Corrosion Inhibitors.* Corrosion inhibitors control corrosion by accelerating or enhancing the formation of a protective film to serve as a barrier between the water and the pipe or solder surfaces. The most commonly used corrosion inhibitors include orthophosphates and silicates (although silicates may be more effective for reducing corrosion of iron or galvanized pipe than lead and copper pipe and solder). Recent data indicate that zinc orthophosphate may be the most effective corrosion inhibitor for lead pipe and solder (AWWARF, 1985).

Corrosion inhibitors have been used for years to reduce water corrosion by all sizes of water systems. Estimated costs for controlling corrosion with inhibitors range from $0.91/1,000 gallons for systems serving less than 100 persons to $0.007/1.000 gallons for systems serving more than 1,000,000 persons (EPA, 1988h).

d. *Consideration of Disinfection Needs in Designing Corrosion Control Treatment.* Use of corrosion inhibitors or adjusting the pH and alkalinity of water to reduce its corrosiveness toward lead and copper can have unintended effects on the quality of finished water. Water treatment should be carefully designed to account for the following circumstances.

Adjustment of pH can affect the effectiveness of disinfectants. For instance, if systems use chlorination for disinfection, elevation of pH should be delayed, to the extent possible, until just prior to when the water enters the distribution system. This will maximize the contact time during which disinfection with chlorine is most efficient (since chlorination is most effective at low pHs) while also optimizing corrosion control in the distribution system.

Since elevated pHs may increase trihalomethane (THM) formation in the distribution system, systems using surface water sources should assure maximum THM precursor removal by optimizing the clarification process prior to increasing the pH. Systems using groundwater sources with high concentrations of THM precursors may need to install treatment to remove such precursors (e.g., membrane filtration) or use alternative disinfectants to free chlorine (e.g., chlorine dioxide or ozone followed by chloramines) in order to achieve adequate disinfection, minimize THM formation, and control corrosion at the same time. In certain cases, THM formation and the need to remove THM precursors may be reduced if orthophosphates or another corrosion inhibitor is used, as these chemicals work best at pHs somewhat below 8.

e. *Materials Benefits of Corrosion Control Treatment.* EPA recently published an analysis of the benefits of reducing lead levels in drinking water (EPA, 1986a). This analysis included an estimate of the materials benefits (in terms of reduced pipe corrosion and failure, increased service life for water meters, etc.) that are likely to result from requiring water suppliers to install corrosion control treatment. The report estimated that the materials benefits alone of corrosion control would exceed by more than two times the costs of implementing the treatment.

Further, a National Bureau of Standards report estimated that 20 percent of the costs of reported damage from water supply corrosion costs were avoidable by the use of control measures (Bennett et al., 1979). The national annual costs of damage from corrosion in the water supply field were estimated at $700 million in 1975 (or $1,300 million in 1986 dollars). However, these costs are only for distribution systems; often far greater corrosion costs are incurred through damage to interior piping and plumbing systems within buildings (Ryder, 1980). Corrosion control by suppliers would reduce these damages as well.

2. Lead Service Connection Replacement

EPA evaluated requiring the replacement of lead service, lines, goosenecks, and other lead distribution system piping to control lead in drinking water. The Agency has estimated that there are approximately 4.4 million lead service lines in use in the U.S. and that

about 25 percent of all public water suppliers have at least some lead service lines. The number of lead service lines as a percentage of total service lines in any community with lead services varies from one percent to 80 percent (Chin and Karalekas, 1984). While most cities stopped installing lead services after about 1940, at least one large city (Chicago) continue to require their use until late 1986.

Lead service lines can contribute significantly to lead levels in tap water, especially where water is corrosive. In Karalekas et al. (1976), for example, lead levels in samples from lead service lines (called "early morning samples" in this study) averaged 0.104 mg/1 as compared to morning first draw levels (called "standing samples") in those same homes which averaged 0.053 mg/1. Similarly, Pocock (1980) and the U.K. Department of the environment (1982) found an elevation in lead levels in morning first draw samples in homes without interior lead plumbing but with lead service lines (called "communication pipe" in Pocock); these first draw levels were lower than in homes with interior lead plumbing and higher than in homes without any lead pipes (either as interior plumbing or as service lines). Because lead service lines can raise lead levels at the tap, and for reasons related to system operation and maintenance (e.g., to avoid anticipated pipe failures), several communities around the United States have already begun programs to replace lead service lines.

The studies cited above as well as unpublished data from two other cities (see Tables 8 and 9) indicate that not all houses with lead service lines have high lead levels at the tap, expecially where water is relatively non-corrosive. The reasons for this vary. One possible explanation is that over time an insoluble protective coating can build up on the interior surface of the lead pipe, preventing (or reducing) the leaching of lead into the water. The buildup of this film is subject to conditions that can vary from house to house including the age of the plumbing, the occurrence of physical disturbances such as the ground freezing or nearby road repair, fluctuations in pH or water pressure, and the length and diameter of the lead pipe. Another possible explanation is that the samples taken in some of these studies may not have fully captured the contribution from the lead service line, e.g., if morning first draw samples, rather than service line samples, were taken (morning first draw samples are not a reliable predictor of the contribution from the service line). This can be seen in the Karalekas, et al. (1976) data cited above: the service line samples, which were intended to capture the effect of the lead pipes on tap water, showed the highest lead levels. In the Pocock (1980) data as well, the presence of lead service lines raised the morning first draw lead levels only slightly. Given the available data, EPA cannot currently quantify, on a national basis, the contributions of lead service lines and other lead connections to lead levels at the tap, or the anticipated change in lead levels after corrosion control treatment is in place. EPA solicits data to help clarify this issue.

TABLE 8.—AVERAGE LEAD CONCENTRATION FOR LEAD VS NON-LEAD SERVICE LINES [1, 2]

City	Pipe type	pH	Alk [3]	Morning first draw average (Pb in μg/l)	Service line average (Pb in μg/l)	Fully flushed average (Pb in μg/l)	Number of samples	Vol.
Chicago	Lead	8.3	100	13	15	8	201	500
	Iron	8.3	100	3		<3	73	500
Louisville	Lead	8.6		8	5	3	34	250
	Copper	8.4		9	3	2	12	250
St. Louis	Lead	9.0	50	<1	<1	<1	2	1,000
	Copper	9.0	50	4	3	<1	9	1,000

[1] Source: EPA, 1988*h*.
[2] Values are for reported sample sizes.
[3] Alk=alkalinity in mg/l as $CaCO_3$.

TABLE 9.—RANGE OF LEAD CONCENTRATION FOR LEAD VS. NON-LEAD SERVICE LINES [1, 2]

City	Pipe type	pH	Alk [3]	Morning first draw average (Pb in μg/l)	Service line average (Pb in μg/l)	Fully flushed average (Pb in μg/l)	Number of samples	Vol.
Chicago	Lead	8.3	100	<3–85	<3–127	<3–44	201	500
	Iron	8.3	100	<3–6		<3	73	500
Louisville	Lead	8.6		ND–20	ND–15	ND–15	34	250
	Copper	8.4		ND–10	ND–7	ND–5	12	250
St. Louis	Lead	9.0	50	<1	<1	<1	2	1,000
	Copper	9.0	50	<1–13	1–10	<1	9	1,000

[1] Source: EPA, 1988*h*.
[2] Values are for reported sample sizes.
[3] Alk=alkalinity in mg/l as $CaCO_3$.

A further complication of the pipe replacement issue is that ownership and/or control of the service line often is split between the public water system and the property owner. Depending on State law or regulations or local ordinances, some public water systems own and/or control service lines and other connections up to the property line, others own and/or control the service line and other connections up to the building (especially if the water meter is located inside the building), and still others own and/or control the service line and other connections only up to the curb. (See Figure 1 for a schematic drawing of the parts of the water supply and distribution system.)

EPA believes that, in general, its authority to require replacement of service lines and other connections ends where the water supplier ownership or control of the lines end. EPA has conducted a limited study of some large

cities, which indicates that these water suppliers generally limit maintenance on water pipes to those portions they own (EPA 1987d). However, several cities have authority to enter private property to perform work on water lines under special circumstances (EPA 1988j); in such cases, the property owner is generally billed for the work performed.

Several cities currently conduct programs to accelerate the replacement of portions of the lead services and goosenecks under their control. San Francisco, CA, began a program in the early 1960's, and replaces approximately 11,500 linear feet of service line per year at an average cost of $40 per linear foot. The service line from the water main to the water meter is replaced with polybutylene, copper, or ductile iron, depending on line diameter. New Haven, CT, has replaced all lead and galvanized steel service lines (from the water main to the meter) and began accelerated replacement of lead gooseneck connections in 1976–77. New Haven has replaced 15,000 of an original 30,000 lead goosenecks to date, at a rate of about 1,000 per year. Akron, OH began replacing lead and galvanized steel service lines from the water main to the curb in 1964, and has replaced about 1,000 service lines per year since then. In all of these cases, the service line replacement was funded by operating revenues paid by the customers. Washington, DC has a program under which they city will replace its portion of lead service lines provided that the building owner replaces his or her portion.

While many studies indicate that lead service connections can contribute to tap water levels of lead, EPA currently has no data to quantify the extent of reductions in lead levels that might be achievable by partial replacement (i.e., by replacing only that portion under the ownership and/or control of the PWS). One study (Britton and Richards, 1980) found temporary increases in lead levels at the tap following the replacement of part of a lead service line with copper piping. As the authors noted, this probably resulted from the dislodgement of the protective coating on the inside of the pipe, possibly aggravated by the application of new lead solder to connect the new pipe, and the occurrence of galvanic corrosion related to the introduction of a dissimilar metal. Because EPA does not have the authority to require the replacement of lead service lines owned and controlled by private property owners, the Agency is concerned that a requirement to replace lead service lines would result in only partial replacement of many such lines. EPA solicits any available data on the effect of partial and full lead service line replacement programs on lead levels at the tap. EPA also solicits information on the extent of the authority of public water systems over lead service lines and connections under State law and local ordinances.

3. Public Education About Lead in Drinking Water

EPA has conducted public education programs and has found that well designed and implemented programs can be an effective means of reducing public exposures to environmental hazards. Public education programs have effectively changed the knowledge and/or behavior of their audiences. Examples of such programs are the State and EPA radon programs and programs to educate residents near Superfund sites about the degree of hazard presented by improperly disposed chemicals at these sites.

Since 1986 EPA has sponsored a major program to educate the public about the dangers of exposure to radon. Many elements of this program have actually been carried out by State and local governments. The program has included monitoring of homes and other buildings for radon in the air, and development and testing of innovative exposure reduction methods, including both prevention and removal techniques. Information has been conveyed throughout the community through an ongoing program of pamphlets, public service announcements, television specials, public meetings, and other means. As a result of this program, many people have become aware of the effects of exposure to radon on health and have taken steps to determine their exposure and protect themselves.

A second successful public education program deals with health risks associated with specific hazardous waste disposal sites under CERCLA (Superfund). Federal, State, and local governments, together with private parties, provide intensive information to people living or working near hazardous waste sites. Using the methods discussed above, affected persons have learned about the nature of the dangers they may face and have learned appropriate steps to reduce their current and possible future exposures to contaminants at these hazardous waste sites.

All public education programs have two basic elements: the content of the program and the method of delivering the information.

a. *Content of the Program.* An effective public education program for lead in drinking water includes information about:

(a) The health reasons for concern about lead exposure, including identification of sensitive subpopulations;

(b) Sources of lead exposure (including non-drinking water sources) and a plan to identify the sources of specific problems in individual houses that are identified as having lead levels above a maximum value;

(c) Means of reducing lead exposure from drinking water, including tap flushing and suggestions for modifying water use patterns to conserve water given the benefits of flushing.

b. *Conveyance of Message.* The effectiveness of public education programs varies depending upon how the message is conveyed to the community in general and to key groups in the community. For example, bill enclosures, public service announcements, public meetings, and messages on water bills will vary in effectiveness since they present the message in different ways and to different consumers.

Identification of key groups in the community can be important in improving the effectiveness of public education programs in reducing exposure to lead by targeting them for more intensive public education efforts. Key groups can include residence in areas identified as at risk for high lead levels in drinking water or houses that actually have been tested and found to have high lead levels; schools and other buildings that have a high proportion of children in their population; and institutions that may serve a high proportion of pregnant women.

Finally, the frequency and duration of the various aspects of a public education program can influence its success.

4. Selection of Treatment Technique Requirements for Controlling Corrosion By-Products

In the above discussion, EPA has reviewed three potential methods of reducing lead and copper as corrosion by-products in drinking water: Corrosion control treatment, pipe replacement, and public education. Based on its evaluation of the available information, EPA considers corrosion control and public education to be effective and feasible methods of reducing lead and copper as corrosion by-products in drinking water. Thus, they are both included as requirements of the proposed rule. Lead service line replacement was also considered. EPA believes that in many cases replacement

of lead service lines and connections may reduce the lead levels in tap water. However, there may be temporary risks associated with partial pipe replacement. Because of these potential risks, as well as uncertainty about the effectiveness of partial or complete service line replacement as a final control step after implementation of corrosion control treatment, EPA is not proposing service line replacement as BAT for controlling lead as a corrosion by-product in drinking water. However, as explained below, EPA is requesting comment and data on this subject and is considering adopting pipe replacement as a requirement of the final rule.

E. Proposed Regulation

EPA is proposing an MCL for lead in distributed water of 0.005 mg/1 and an MCL for copper in distributed water of 1.3 mg/1. Compliance would be measured at the entry point to the distribution system.

The Agency is also proposing a treatment technique requirement to control lead and copper which enters water as corrosion by-products. The proposed treatment technique consists of optimal corrosion control treatment to minimize lead corrosion, and public education. It would be triggered by three "no-action" levels, as measured in targeted samples: an average lead concentration in targeted samples of less than or equal to 0.010 mg/1, a copper concentration of 1.3 mg/1 or less in at least 95 percent of the targeted samples, and pH greater than or equal to 8.0 in at least 95 percent of the targeted samples. If all three levels are met, "no action" would be required; the PWS would be deemed in compliance with the treatment technique. If any of these three levels is not met by a system, the system would be required to install or improve its corrosion control treatment. In addition, if the average lead level of 0.010 mg/1 or a fourth "no-action" lead level of 0.020 mg/1 or less (in at least 95 percent of the targeted samples taken for compliance) was exceeded, the PWS would be required to conduct a public education program to encourage consumers to reduce their exposures to lead in drinking water.

The Agency is seeking comment on six major alternatives which are permutations of this proposal. First, EPA is considering treating the fourth no-action level, 0.020 mg/1 or less of lead in at least 95 percent of the targeted samples, the same as the first three no-action levels. Thus, a system that did not meet this fourth no-action level would be required to install or improve its corrosion control treatment. The second alternative would add an additional "no-action level" of total alkalinity greater than or equal to 30 mg/1 in 95 percent of more samples to trigger treatment. As in the first alternative, a system that did not meet this no-action level would be required to install or improve corrosion control treatment. The third alternative would eliminate the pH no-action level and rely only on lead levels measured at the tap to determine whether corrosion control treatment is required. Under the fourth alternative EPA is considering, a system would be required to replace lead service lines and connections that were found to contribute 0.005 mg/1 lead or more to lead levels in tap water even after installation of optimal corrosion control treatment. The fifth alternative under consideration is a two-tier approach to monitoring which could increase the efficiency of sampling and accuracy of determinations regarding whether additional corrosion control treatment was required. This alternative may also reduce the number of samples required of larger public water systems. A sixth alternative EPA is considering would eliminate the MCLs for lead and copper in distributed water.

This section and the following section on monitoring describe each part of the proposal and these alternatives, and explains the rationale for selecting the proposed rule provisions and for considering each alternative. EPA requests comment on the proposal itself, as well as the alternatives. In response to the public comments, EPA may promulgate any of these alternative options or any combination of these options. Persons should, accordingly, comment fully on all these options.

In its July 8, 1987 (52 FR 12876) notice promulgating NPDWRs for eight VOCs, EPA added a definition of a non-transient non-community (NTNC) water system to the general definitions section in 40 CFR §141.2. The definition of a non-transient non-community water system is as follows:

> a "non-transient non-community water system" means a public water system that is not a community water system and that regularly serves at least 25 of the same persons over six months per year.

In that rulemaking, EPA applied the NPDWRs for the VOCs to these NTNC water systems. EPA also stated in that notice its intent to apply future drinking water standards to NTNC water systems. Accordingly, EPA is proposing to apply the NPDWRs for lead and copper proposed in today's notice to NTNC water systems as well as to community water systems. EPA recognizes that some of the provisions of the proposed regulations would not easily apply to NTNC systems. Therefore, where appropriate, EPA is proposing modified provisions for NTNC water systems to better suit the special circumstances of the NTNC system. Unless otherwise noted, all requirements in this proposal would apply to community water systems and NTNC water suppliers in the same way.

1. Lead and Copper MCLs

Based on the analysis of treatment technologies in Section IV.B.3., above, and an assessment of the PQL in Section V.A., below, EPA is proposing an MCL of 0.005 mg/1 for lead in water as the water enters the distribution system. The treatment technologies proposed as BAT in Section IV.B.3., (i.e., ion exchange, reverse osmosis, lime softening, and coagulation/filtration) can reduce lead occurring in source water to 0.005 mg/1 at reasonable cost. Based on an analysis of the same treatment technologies, EPA proposes to set an MCL for copper in water entering the distribution system of 1.3 mg/1. The treatment technologies proposed as BAT in Section IV.B.3. are capable of reducing copper found in source water to this level at reasonable cost.

EPA considered making these MCLs applicable to fully flushed water at the tap, rather than to treated water entering the distribution system. However, EPA is concerned that distribution system and household plumbing materials might contribute to fully flushed lead levels at the tap as water moves through the pipes, and tap levels therefore may not reflect the effective application of treatment to reduce lead and copper occurring in source water. Although EPA has few data on such contributions, especially on contributions after application of the corrosion control treatment which would be required by this rule, the available data indicate that plumbing materials can contribute to lead and copper levels in fully flushed samples (EPA, 1988h).

Therefore, EPA is proposing to require that compliance with the MCLs for lead and copper be measured at the entry point(s) to the distribution system. Water suppliers with more than one well or entry point to the distribution system would be required to monitor at each entry point to ensure identification of all sources requiring treatment. Where several wells draw from the same aquifer, States would be allowed to identify wells representative of the aquifer for monitoring if there is no treatment; monitoring of the remaining wells would not be required. States would also be allowed to reduce the

total number of samples by the use of composite samples, described in Section V.C.1. below.

Measuring at the entry point to the distribution system would accurately reflect whether the treatment of the source water was effectively applied. While contributions to the lead and copper content of fully flushed water from plumbing materials in the distribution system may be small, even a contribution of 0.001 mg/l from corrosion could result in a violation of the lead MCL when in fact the source water has been treated to reduce lead levels in the source water to below the MCL. A larger contribution would be required for copper, but the same concern exists. EPA solicits comments on both the proposed approach and the alternative of requiring that the MCLs apply to fully flushed water at the consumer's tap.

To demonstrate compliance with the MCL for lead, water suppliers would be required to monitor lead in water entering the distribution system and maintain the lead level at or below 0.005 mg/l in all samples. To be in compliance with the MCL for copper, water suppliers would be required to monitor copper levels in water entering the distribution system and maintain the copper level at or below 1.3 mg/l in all samples. These requirements would apply to both community water systems and non-transient, non-community water systems. Monitoring would begin no later than the dates specified in Section V.C.1 (depending on system size).

It has been suggested that an MCL for contaminants entering the distribution system is a contradiction in terms because an MCL, by definition, is a standard that must be met at the tap. Proponents of this view argue that the SDWA, the legislative history of the Act, and EPA's own regulations support this interpretation.

The Safe Drinking Water Act defines an MCL as "the maximum permissible level of a contaminant in water which is delivered to any user of a public water system." Section 1401(3). It certainly could be argued that, under this definition, MCLs must be met in water that actually flows from the user's tap. Indeed, the House Report on the bill that eventually became the Safe Drinking Water Act of 1974 states that "[s]ince drinking water regulations are intended to be met at the consumer's tap, the committee anticipates that monitoring would include tap sampling." (H.R. Rep. No. 93–1185, p. 13, 1974). On the other hand, it could be argued that "water which is delivered to any user" refers to water that leaves the part of the distribution system that is owned or controlled by the public water system and enters the portion of the distribution system that is owned or controlled by the user, e.g., homeowner. This interpretation would be consistent with the definition of "public water system" in section 1401(4) of the Act which, as discussed earlier, does not include distribution facilities that are not owned or controlled by the public water system.

In determining where MCLs apply, EPA's regulations are not conclusive. In 40 CFR 141.2(c), EPA defines "maximum contaminant level" as:

> the maximum permissible level of a contaminant in water which is delivered to the free flowing outlet of the ultimate user of a public water system, except in the case of turbidity where the maximum permissible level is measured at the point of entry to the distribution system. Contaminants added to the water under circumstances controlled by the user, except those resulting from corrosion of piping and plumbing caused by water quality, are excluded from this definition.

The "free flowing outlet of the ultimate consumer of a public water system" apparently refers to the user's tap. Under this interpretation, all MCLs, except the MCL for turbidity, apply at the tap. However, many of the NPDWRs the Agency has promulgated appear inconsistent with this definition because they do not require monitoring, and therefore compliance, at the user's tap. For instance, the NPDWR for coliform bacteria requires that "samples * * * be taken at points which are representative of the conditions within the distribution system." 40 CFR 141.21(a). While this provision does not preclude sampling at the consumer's tap, it does not require it. Some NPDWRs actually preclude compliance monitoring at the tap. For instance, in 40 CFR 141.24(g)(1), the NPDWRs for VOCs that EPA promulgated in 1987 state that "[g]round water systems shall sample at points of entry to the distribution system representative of each well." Also, the NPDWR for fluoride requires sampling at the entry points to the distribution system. 40 CFR 141.23(g)(1). Other NPDWRs are silent; for instance, most of the NPDWRs for inorganic contaminants (other than fluoride) do not specify the sampling (or compliance) point. See 40 CFR 141.23.

Of course, for contaminants other than corrosion byproducts, sampling at the tap is not critical since water leaving a treatment plant is generally expected to remain consistent in quality throughout the distribution system, including the portion owned or controlled by the consumer. In fact, for some contaminants, the level at the tap may even be lower than the level at the entry point to the distribution system because of dilution (e.g., mixing of sources) or volatilization of contaminants from water.

Thus, EPA's regulatory definition of MCL arguably is inconsistent with both the statutory definitions of "MCL" and "public water system" and the monitoring requirements for many current MCLs. EPA believes it is important to clarify that, for all contaminants regulated under the Safe Drinking Water Act, the point of compliance is defined by the monitoring requirements of each NPDWR. Therefore, in this notice, EPA is proposing to amend the definition of "maximum contaminant level" to match the statutory definition. Then, for each NPDWR that specifies an MCL, the Agency will specify the monitoring requirements, including the sampling locations, which will in turn define the point of compliance. In the case of the lead and copper MCLs, therefore, the sampling point and point of compliance would be the entry point to the distribution system. While these levels may not necessarily be the "maximum levels delivered to any user," because lead and/or copper levels will probably increase from corrosion within the distribution system, these MCLs, measured as specified in the proposed rule, (1) would indicate whether the treatment for lead and copper in source water was effective, and (2) assess the minimum lead and copper levels that can occur at the tap.

2. Treatment Requirement for Lead and Copper as Corrosion By-Products

The treatment technique required by this rule consists of optimal corrosion control treatment (to minimize lead and copper leaching) and public education (to reduce exposure to lead). Systems could comply with the treatment technique either by installing treatment and conducting a public education program, or by meeting specified "no-action levels" for parameters of concern. Thus, under this proposal, systems that meet specified levels for lead, copper, and pH, i.e., no-action levels, would be deemed in compliance with the treatment technique requirement and would not be required to install or improve treatment of their water. Systems that do not meet the no-action levels would be required to either improve or install corrosion control treatment adequate to meet the no-action levels or else demonstrate that they have optimized treatment, i.e., that the delivered water is minimally

corrosive towards lead. In addition, if one or both lead no-action levels are exceeded, the system would be required to conduct a public education program.

EPA is proposing no-action levels as a screen to limit the total number of public water systems which would need to make a detailed demonstration that they have optimized corrosion control treatment. These limits are called "no-action levels" because no further actions are required if they are met. Thus, under this proposal, a system that meets the no-action levels, i.e., 95 percent of samples at the tap with pH 8, lead levels at the tap of 0.010 mg/l or below as an average, and 95 percent of copper levels at the tap of 1.3 mg/l or below, would be considered to have minimally corrosive water and would be considered in compliance with the corrosion control portion of the treatment technique requirement. Such a system would not be required to perform a detailed demonstration that it had installed optimal corrosion control treatment. A system that meets the average of 0.010 mg/l of lead and 95 percent or more of its samples are less than or equal to 0.020 mg/l lead would be considered to be in compliance with the public education portion of the treatment technique requirement.

To determine whether it meets the no-action levels, the water system would first take morning first draw and service connection samples from kitchen taps in targeted residences as described in Section V.B.2. below. For systems serving more than 3,300 people, the first round of monitoring (four quarters) would be required to be completed during the 15 months after promulgation of the final rule. Water suppliers serving 500 to 3,300 people would have 27 months from promulgation to complete the initial monitoring. Systems serving fewer than 500 people would be required to complete the initial monitoring 39 months after promulgation of the final regulations. Non-transient non-community water systems would be required to complete their required monitoring according to this schedule, depending on the number of people served by the system. All other time deadlines are expressed in terms of time elapsed since the deadline for completion of the initial monitoring. These requirements are summarized in Figure 2. The remainder of this section describes these requirements in more detail.

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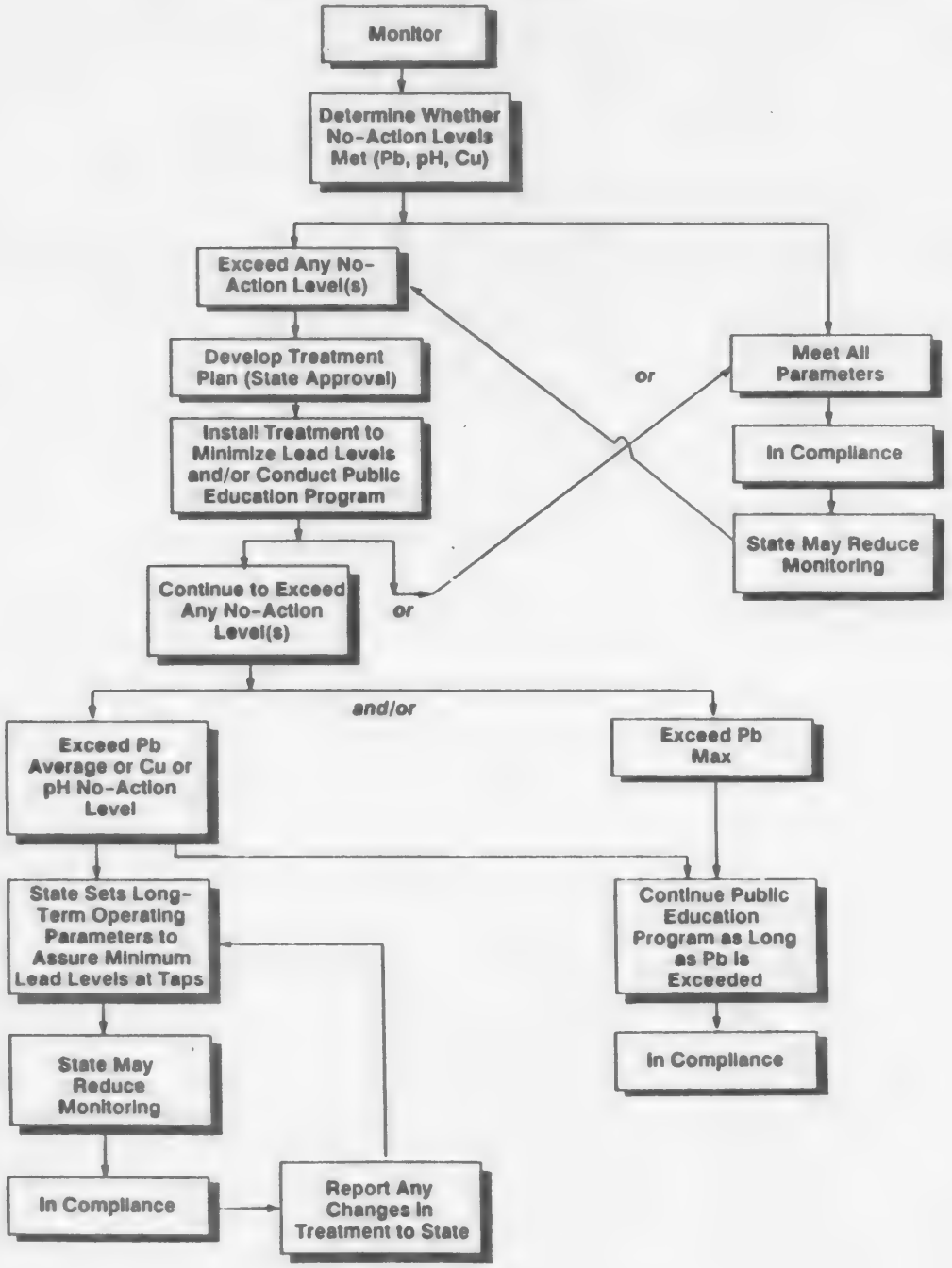
Figure 2

Treatment Technique Requirement


Monitor
Determine Whether No-Action Levels Met (Pb, pH, Cu)
Exceed Any No-Action Level(s)
Develop Treatment Plan (State Approval)
Install Treatment to Minimize Lead Levels and/or Conduct Public Education Program
Continue to Exceed Any No-Action Level(s)
or
Meet All Parameters
In Compliance
State May Reduce Monitoring
and/or
Exceed Pb Average or Cu or pH No-Action Level
Exceed Pb Max
State Sets Long-Term Operating Parameters to Assure Minimum Lead Levels at Taps
State May Reduce Monitoring
In Compliance
Report Any Changes in Treatment to State
Continue Public Education Program as Long as Pb is Exceeded
In Compliance

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Systems failing to meet the no-action levels by the deadline for completion of the initial monitoring would be required to install corrosion control treatment, and/or public education, depending on which of the no-action levels is exceeded. Corrosion control treatment and public education would be required to be implemented according to a State-approved or issued treatment plan. The treatment plan would contain specific steps that each water supplier would be required to take to ensure that either the no-action levels are met, or optimal corrosion control treatment and/or public education are implemented, on a specified schedule. All systems would be required to complete installation of any treatment required by the treatment plan within three years after approval of the plan.

Water systems serving 3,300 or more people and failing to meet anyone of the no-action levels would be required to apply for approval of a treatment plan by submitting a proposed treatment plan to the State within one year after the deadline for completion of the initial monitoring. These systems would required to include in their treatment plan the following steps: (1) Design and implementation of pipe loop, laboratory, pilot scale and/or field studies; (2) analysis of the data generated in these studies to estimate optimal operating conditions to minimize corrosion of lead; (3) installation of the treatment in the entire water supply system; (4) monitoring to evaluate the effectiveness of the treatment; (5) additional adjustment of the treatment if no-action levels continues to be exceeded; and (6) if, after installation and adjustment of treatment, any of the no-action levels continue to be exceeded, submission to the State of all data collected and an analysis demonstrating that the corrosion control treatment being applied was optimal, i.e., that lead levels were minimized.

The State would be required to review the system's analysis and determine whether treatment was optimal. Once the State determines that treatment is optimal, the State would also specify required operating parameters and values (such as pH, total alkalinity, or corrosion inhibitor dose rate or residual) to ensure that optimal treatment continues. These operating parameters may vary by season to account for seasonal variations in water corrosivity. States would be expected to periodically review and revise the specified operating parameters if long-term monitoring shows increasing average lead levels, or that different values for the specified parameters result in lower lead levels.

Water systems serving fewer than 3,300 people would be required to apply to the State for a treatment plan if any of the no-action levels is exceeded at the end of the initial monitoring period. Systems would be required to submit or apply for the plan within one year after the close of the initial monitoring period. States would specify the required corrosion control treatment in the treatment plans for these systems. The treatment plans would include a schedule for completion of Steps 3–6 described above for systems serving more than 3,300 persons. States would also specify final operating parameters for these systems after treatment is applied and follow-up monitoring conducted. EPA is proposing that States specify the appropriate treatment for these systems because most smaller systems are unlikely to have the resources and expertise necessary for determining what corrosion control treatment is appropriate. However, systems that wish to develop and submit their own treatment plan rather than request one from the State are encouraged to do so.

a. *Corrosion Control*—i. *No-Action Levels.*

As described above, if pH is 8.0 or greater (in 95 percent of targeted samples), lead levels in targeted samples have an arithmetic average of 0.010 mg/l or lower, the maximum lead level in 95 percent of targeted samples does not exceed 0.002 mg/l, and the copper levels in 95 percent of targeted samples does not exceed 1.3 mg/l, the system would be deemed in compliance with the treatment technique requirement and need not install or improve corrosion control treatment.

The value of 0.010 mg/l as an arithmetic average for lead levels is based on engineering considerations. EPA reviewed the available literature and data on lead levels in standing samples (water standing in the pipes 8–18 hours), compared with the various plumbing materials water quality factors (particularly pH and alkalinity) present. Analysis of these data indicates that, for those water suppliers having water with pH 8 and total alkalinity greater than 30 mg/l, even in the presence of some lead plumbing materials, average tap lead levels of 0.010 mg/l were achieved.

Systems with no lead problem or only a small lead problem (e.g., no lead service lines and few houses with new lead solder) would be able to meet the average of 0.010 mg/l relatively easily, especially if they meet the no-action level for pH. Some systems may have more difficulty consistently meeting the average. For example, as described above, Boston, MA and Bennington, VT have had serious lead problems in the past due to large numbers of lead service lines and residences with interior lead plumbing combined with water which was extremely corrosive before treatment, and thus have instituted corrosion control programs aimed at reducing lead to below 0.050 mg/l. Both raised their pH to above 8.0 at the treatment plant, and Bennington raised its raised their alkalinity some. Because alkalinity levels remain low, pH levels are not maintained throughout the system. Although both communities achieved substantial reductions in morning first draw lead levels, and met their own program goals of reducing tap lead levels below 0.050 mg/l, neither is meeting the 0.010 mg/l target as an average. However, the treatments developed for these cities may not be optimal for their water; additional reductions are likely to be possible.

The proposed treatment technique requirement would include a no-action level for copper equal to the MCLG, 1.3 mg/l, as a 95th percentile of the data in morning first draw water. This level is based on a review of the literature and data on copper levels in morning first draw samples. These data indicate that with good corrosion control, particularly pH adjustment, copper levels in morning first draw water can be consistently reduced to the MCLG or lower (EPA, 1988h).

ii. *Treatment Plan Requirements.* If a water supplier did not meet one or more no-action levels, it would be required to submit or apply for (depending on their size) a treatment plan. The plan would be designed to result in having the system meet the no-action levels or, if the system did not meet the pH and/or average lead level after applying optimal treatment, demonstrate that lead levels in tap water had been minimized. (The treatment plan would also include public education requirements if the average or maximum lead level is not met. This aspect of the treatment plan is discussed in a later section.) Systems must submit or apply for a treatment plan within one year after the end of the initial monitoring period showing that any no-action level has been missed.

The contents of the plan, including items such as specific schedules, studies, and installation of treatment, would become effective and enforceable upon approval or issuance of the plan by the State. Factors affecting the scope and detail necessary for successful optimization showings include: Local

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water chemistry conditions, size and complexity of the distribution system, and the presence of other water treatments which can affect the design and effectiveness of potential corrosion control measures. Compliance would be determined based on whether a system had fulfilled each step of the approved plan on time and in a manner meeting minimum Federal and State criteria.

After the system has taken all the steps required by the plan, the State would evaluate the results and specify operating conditions for future compliance. The system would be required to operate in the manner specified by the State (either meeting the no-action levels or operating under other conditions approved by the State that minimize the corrosivity of the water towards lead) to remain in compliance in future monitoring periods. Failure to meet the no-action levels or demonstrate that treatment is optimal would be a violation of the treatment technique requirement. Systems that meet all the no-action levels during the initial monitoring period, but exceed one or more of them during a subsequent monitoring period, would have one year after their monitoring data showed an exceedance of any no-action level to either meet the no-action level or submit or apply for a treatment plan.

(A) *Large and Medium Size Systems.* Systems serving more than 3,300 persons would be required to submit a proposed plan which describes the system's approach to obtaining the information necessary to install or improve treatment sufficient to achieve the no-action levels or to demonstrate that corrosion control treatment has minimized lead levels at the tap due to corrosion. EPA expects that water suppliers facing situations more complicated than average, such as large systems, would need to perform more elaborate studies to determine optimal operating conditions. A simpler than average evaluation may suffice in cases where the choice of appropriate corrosion control is fairly obvious. The treatment plan for these systems would include the following specific steps and a schedule for completing each step:

Step 1: Pipe loop, laboratory, pilot scale studies, and/or field studies demonstrating reductions in lead and copper levels in actual or simulated standing samples corresponding to application of optimal corrosion control treatment.

To identify and demonstrate to the State that water is minimally corrosive towards lead or achieve the no-action levels, water suppliers would be required to conduct pipe loop, laboratory, pilot-scale, and/or field studies investigating the effects of changes in corrosion control treatment and corresponding changes in lead dissolution. These studies should include investigations of the effects of varying pH over the range of 8.0 to 10.0, and at several total alkalinity levels.

Those ground water systems with pH below 8.0 that are saturated or nearly saturated with $CaCO_3$, and that wish to continue operating in the pH range, should demonstrate in the laboratory that precipitation problems could occur if pH adjustment is implemented. If these bench-scale studies indicate that $CaCO_3$ would precipitate at elevated pH, then these systems should concentrate their optimization analysis on the use of corrosion inhibitors such as zinc orthophosphate.

In addition, systems which prefer to operate outside the required pH range because of other water treatment considerations (such as preference for using corrosion inhibitors, which function better at lower pH, e.g., pH <8.0, so formation of trihalomethanes and other disinfection by-products is less likely) also could apply for treatment plan approval. Systems that want to operate outside the minimum pH must also describe use of any corrosion inhibitors which provide optimum protection outside the preferred pH range, and show in pipe loop or other studies approved by the State in the treatment plan that lead levels under these conditions are higher than lead levels which result under the water supplier's preferred operating conditions. The supplier must test a range of corrosion inhibitor doses and sufficient alternative operating conditions to show that the lead levels cannot be lowered using other treatments such as alternative corrosion inhibitors.

If a pipe loop study is used to evaluate different treatments, then the pipes used for the study must be representative of the plumbing in the system that is causing the lead problem. Lead pipes would be required if lead service connections are used within the system. Lead-soldered copper joints must be used if the lead problem is the result of corrosion of these joints within the system. Because of differences in conditions between residences and pipe loops, the loops will generally not predict the precise treatment necessary and resultant lead levels for a system. However, they will accurately predict trends and provide data to plan a treatment strategy and to design and test pilot and field scale studies, as part of the treatment scale-up and adjustment.

Step 2: Analysis of the data generated in Step 1 above to identify water quality conditions under which lead levels in morning first draw and service connection samples (i.e., standing samples) are expected to be minimized.

The purpose of the studies conducted under the treatment plan is to identify water quality conditions under which corrosion of lead into tap water is minimized and to demonstrate that lead levels in water have been minimized under the operating conditions for which the water supplier seeks approval (if it cannot meet the no-action levels after installing or improving treatment). The results of the studies should clearly and unambiguously show the relationship between minimal water lead content and the proposed operating conditions. That is, data gathered under both the operating conditions identified by the water supplier as optimal and alternative conditions would be required. The State would evaluate the data to assure that the chosen conditions provide the lowest possible lead levels.

In conducting these studies, there may be a period before the full effect of the pH adjustment is expected to be realized. The system would analyze standing samples from the pipe loop or other experimental set up for lead during this period to assess the effectiveness of the pH adjustment. Those systems that do not meet the average lead level at any of the pHs within the specified range (i.e., 8–10) would then analyze the generated data to determine the optimum pH, i.e., the pH which results in the lowest lead levels. The system would then adjust the pH to the optimum pH and establish permanent operating levels for pH and any other parameters specified by the State.

For systems which choose to investigate corrosion inhibitors, lead levels resulting from a range of doses would be required, and would be compared with the results of studies using pH adjustment above.

Based on these analyses, a treatment strategy and estimated operating parameters for minimizing corrosivity of water in the whole system would be identified.

Step 3: Installation and operation of corrosion control treatment in the water system as a whole.

EPA anticipates that most of the overall demonstration of optimal treatment would be completed in the laboratory or in a pilot plant as part of Step 1. Only after a PWS has determined the general requirements for treatment would EPA expect it to apply

the treatment in the distribution system. EPA believes this sequential process is important to assure that protective coatings are not accidentally disturbed during the trials, and to allow systems to make cost-efficient decisions regarding treatment strategies and the installation of new equipment.

The system would be required to scale up its laboratory treatment to install it in the system as a whole within three years of approval of the treatment plan. The goal of the scale-up would be to identify full scale treatment that would achieve in the system as a whole the operating parameters identified in Step 2 above as likely optimal operating parameters, or to meet the no-action levels.

Step 4: Monitoring to determine the efficacy of the treatment as installed.

The treatment plan must require monitoring of the full-scale implementation of the operating conditions determined from the laboratory and pilot studies. Monitoring would be required at the same sites used to evaluate compliance with the no-action levels.

Systems adjusting pH (and alkalinity) may have a several-month stabilization period before the full effect of the corrosion control treatment is realized. The pH level will stabilize first, while lead levels may continue to fall as a film builds up on the inside of the pipes. Systems should sample at the targeted sites during this period to determine the effectiveness of the corrosion control treatment. This monitoring should show lead levels decreasing and stabilizing over time as the treatment takes effect. Once the system has stabilized, samples from the targeted sites would be analyzed for lead to demonstrate the effectiveness of the treatment at full scale.

Step 5: Adjustment of the installed treatment as necessary to ensure that lead levels are minimized.

Once the general treatment steps are determined and installed to treat the full system to meet the water quality parameters identified, EPA expects that most water suppliers would need to fine-tune the treatment to account for normal differences between laboratory or pilot plant designs and full scale operations. The installed treatment must also be adjusted for seasonal variations in water quality which can greatly affect the corrosivity of the water. Water suppliers must adjust the installed treatment as necessary to account for differences between projections based on laboratory or pilot plant data and full-scale operations by performing minor adjustments or pH or other parameters to try to reduce the lead levels.

If, upon implementation of the operating parameters identified by the system in the laboratory studies, a system meets the no-action levels for four consecutive quarters, then the system has adjusted its corrosion control treatment sufficiently and no further adjustment would be required.

Note that because tap water must meet the proposed no-action levels or be shown to be minimally corrosive towards lead, water suppliers would be required to adjust corrosion control treatment to account for any blending of water from different sources. There can be significant changes in water chemistry associated with blending. Therefore, suppliers must demonstrate that each blended product meets the requirements of the regulations. A related issue is that of the division of responsibility for treatment among wholesalers and retailers of water. Retailers may add or blend sources of water provided by several wholesalers. Therefore, EPA is proposing to place ultimate responsibility for the degree of corrosivity of the water on the retailers. EPA solicits comment on this approach and requests data to support any alternative approaches suggested.

Step 6: If any no-action levels are still exceeded after installing or improving treatment and making all adjustments, systems must submit to the State an analysis of all treatment and resulting lead levels demonstrating that treatment is optimal and lead levels are minimized for the specific system.

This report would include a compilation of all the data generated in the course of study and treatment implementation. It must clearly show that additional treatment would not reduce lead levels further. Test results outside the operating parameters identified as optimal must be included. Once the State accepts the analysis and approves a set of operating conditions as optimal, those conditions would become the required operating parameters for that system for the future.

Suppliers serving more than 3,300 persons that wish to change other concurrent treatments that might reduce the effectiveness of the approved corrosion control treatment, or experience significant change in the population served or in the extent of the distribution system, would be required to submit to the State for approval new corrosion control data from studies which reflected the new conditions under which the supplier wishes to operate. These conditions must show that corrosion of lead continues to be minimized.

(B) *Small Systems.* Systems serving fewer than 3,300 persons that do not meet the no-action levels simply would be required to apply to the State for a treatment plan. States would determine what type of corrosion control treatment would result in the minimization of lead levels at the tap and specify this treatment in the plan. (Systems that preferred to develop and submit their own treatment plan would be allowed to do so.) The treatment plan would contain the same performance standard as that required from larger systems—installation of corrosion control treatment to either meet the no-action levels or minimize the corrosivity of tap water towards lead, and an effective program of public education if one or both of the no-action levels are exceeded after treatment. The activities required of small systems to meet this performance standard would be tailored to their ability to perform detailed analyses of alternative corrosion control treatments and to conduct public education programs. For example, rather than conducting pipe loop, laboratory, pilot-scale, or field studies to determine optimal treatment, the State would specify the type of treatment small systems are to install. The State would be responsible for determining what treatment is most likely to be effective in each system. Once the treatment is designated, the responsibilities of small systems would be very similar to those of larger systems. The systems would install and fine-tune the full scale treatment, monitor tap water to assure treatment effectiveness, and continue to meet the no-action levels (if achieved by the specified treatment) or to operate under conditions approved by the State.

EPA recognizes that some corrosion treatments may be difficult to implement for small water suppliers without full-time personnel to monitor and maintain operations. EPA has therefore identified technologies which may be appropriate for the smallest water suppliers, i.e., those serving fewer than 500 persons. Soda ash (sodium carbonate) may be appropriate for some of these small systems. Other systems may require treatment with lower maintenance requirements; limestone bed contactors (calcite contactors) provide a possible alternative. In a limestone contactor, water is closed to the atmosphere and flows through and dissolves a packed bed of crushed limestone or another source of calcium carbonate. Such devices can reduce lead levels in morning first draw drinking water by five-fold and copper by more than 50-

fold (EPA, 1987d). These devices need relatively low maintenance (although they require occasional backwashing), are effective and relatively low in cost, and provide a viable treatment alternative for many small systems. However, there are a few limitations associated with calcite contactors. First, this technology may not be effective for systems with source water that is already saturated with $CaCO_3$. Second, systems that do use this treatment technology may not meet the no-action level for pH, especially if the source water has low pH and low total alkalinity. This treatment technology may need to be coupled with another treatment technology to achieve the no-action levels for both pH and lead. Dolomite contactors may provide treatment similar to that of calcite contactors. While water suppliers may use any treatment to minimize water corrosivity, EPA believes the treatment methods described above may be more practical for the smallest systems, and encourages States to consider them seriously in developing treatment plans for these PWSs.

The treatment plan for systems serving 3,300 or fewer persons would include a schedule for installing and adjusting the treatment designated by the State, and would include the following specific steps, which correspond to Steps (3)–(5) for larger systems (described above):

Step 1: Installation and operation of the corrosion control treatment required by the State in the water system as a whole, within three years of issuance of the treatment plan.

Step 2: Monitoring to determine the efficacy of the treatment as installed.

Step 3: Adjustment of the installed treatment as necessary to ensure that lead levels are minimized.

Step 4: If one or more no-action levels are still exceeded after installation and adjustment of treatment by the system, the State would analyze all treatment and resulting lead levels to determine whether treatment is optimal, i.e., lead levels are minimized, for the specific system. Monitoring data supporting the conclusion that treatment is optimal must be submitted to the State.

Suppliers serving fewer than 3,300 persons that wish to change other concurrent treatments that might reduce the effectiveness of the approved corrosion control treatment, or experience significant change in the population served or in the extent of the distribution system, would be required to notify the State of the proposed changes. States may disapprove the changes and require modifications necessary to preserve the minimal corrosivity of the water.

b. *Public Education.* Under this proposal, those water suppliers (of all sizes) exceeding one or both of the no-action levels for lead (either the average or the maximum) would be required to conduct a public education program to reduce exposure to lead. The public education program would be a part of the treatment plan. Public education would begin as soon as the State approves or issues the treatment plan which includes public education program. States could approve or issue a treatment plan in two steps to allow the public education programs to begin as quickly as possible. In these cases, the State would approve the part of the treatment plan that contains the public education program first, without waiting for final analysis and approval of the corrosion control portion. Two-part approval would be especially useful when the corrosion control laboratory work and scale-up analysis is complicated.

The proposed public education program differs both from the general public notification requirements and the special lead public notification requirements under sections 1414 and 1417 of the Safe Drinking Water Act (see 52 FR 41534, October 28, 1987). First, the public education program would be an ongoing requirement of the NPDWR for lead and copper, for as long as one or both no-action level is exceeded, as opposed to the special lead notification requirement, which is basically a one-time notice. Second, the public education program under this proposal would be required to include intensive interaction between the PWS and its customers to educate them about lead in drinking water, whereas the general public notification program is passive; it simply notifies customers of violations. As explained in Section III. above, excess levels of lead in drinking water supplies can pose a risk to public health. A well designed and executed public education program can induce public water system customers to voluntarily modify their water use behavior, mitigating risks that may result from lead leaching into drinking water.

Water suppliers would be required to design public education programs to meet three performance standards, one regarding program content, a second regarding program delivery, and a third regarding program evaluation, as described below.

i. *Program Content.* The public education program would include information on health reasons for concern about lead exposure, including, in qualitative and quantitative terms, information on specific potential health effects associated with excess blood lead levels and the possible contribution of drinking water to them. As described in detail earlier, these effects include interference with heme synthesis, anemia, kidney damage, impaired reproductive function and fetal effects, interference with vitamin D metabolism, impaired cognitive performance (as measured by IQ tests, performance in school, and other means), delayed physical and neurological development, and elevations in blood pressure (EPA, 1986b). Also, the consumer would be advised that the risks associated with lead in drinking water may be aggravated by exposure to lead from other sources. Other sources include lead from paint chips or paint dust, occupational and home hobby exposures (e.g., smelting, electronics), inhalation of airborne lead, and ingestion of lead in food, especially lead that leaches into food from lead-soldered containers.

Besides identifying the nature of the problem associated with lead in drinking water, the public education program would be required to provide information that the consumer may use to evaluate the probability of excess levels of lead in his or her own household water supply. This information must include the potential for excess lead levels in the water as the water leaves the water supplier and the potential for further increases in the lead levels as a result of corrosion of water supply system components. In addition, the public education program must advise consumers to examine the service line, pipes, and soldered joints in their homes for lead, and faucets and other fixtures for brass, which may commonly contain lead; how to have their water analyzed by a commercial laboratory to determine the lead content; and to contact the PWS for additional information. The program must also include specific information on the banning of materials containing lead for use in drinking water systems. The PWS should be prepared to respond to public inquiries on any issues related to lead in drinking water. EPA solicits comment on additional information that the public education program should include.

The public education program would be required to advise consumers of the actions that may be taken to immediately reduce exposure to lead levels in drinking water that exceed the maximum no-action level, i.e., 0.020 mg/l. These actions include: Non-wasteful flushing of taps (such as dishwashing) before any water from a tap is

consumed or used for any type of cooking or other food preparation including preparation of baby formula; using only cold water for drinking or the preparation of any food or formula; possibly replacing portion of the service line owned by the consumer or landlord if it is made of lead and is contributing significant amounts of lead to the drinking water; ensuring that all plumbing repair work is performed using lead-free solder (explaining that the use of lead solder in drinking water systems is illegal); and providing an electrical ground for household wiring other than the household plumbing system if permitted by local building and electrical codes. The Agency invites comments on the effectiveness of these or any other actions that may be used to effect an immediate reduction in exposure to drinking water lead.

The public education program would require the identification of any actions already taken by any official parties within the community to evaluate, quantify, and/or reduce the levels of lead in drinking water and must publicize the results of compliance and other monitoring for lead (including results of any monitoring arranged by the PWS at the request of a consumer, as described below).

ii. *Program Delivery.* The delivery of the public education program is defined by three factors: The audience, the media used to deliver the program, and the frequency and duration with which the program is delivered.

EPA believes that often it would be appropriate to target the education program to specific segments of the public. For instance, residences with known high lead levels, lead service lines, or lead solder less than five years old would be targeted. However, if many or nearly all of the residences are at high risk, then the program should be conducted community-wide.

The Agency expects many systems already have much information regarding plumbing materials in the distribution system and in homes. Under 40 CFR 141.42(d) systems were required to identify whether lead from pipe, solder, caulking, interior lining of distribution mains, alloys and home plumbing was present, and report the results to the States by 1983. Systems are strongly encouraged to use the results of this identification to assist in the estimation of the prevalence of high risk houses and to assist the targeting of public education programs to those areas of the community most likely to have a large proportion of residences with high lead levels in their water.

Public water systems also would be required to consider whether it is appropriate to target customers on the basis of traits other than geographic location and household plumbing type. For instance, available data indicate that children and developing fetuses are more susceptible to the effects of lead in drinking water than adults are. Therefore, public water systems could target programs to customers that are associated with children and pregnant women. These customers include families, child day care providers, schools, and hospitals. Systems could also target customers with other traits or characteristics that are known to correlate with sensitivity to elevated levels of lead in drinking water supplies such as persons having occupational or other high enviromental exposure, e.g., people working in or living near lead smelters. In addition, bilingual information would be required to be disseminated to non-English speaking portions of the targeted population.

As a part of the public education program, EPA is proposing to require that water suppliers offer a program of extended monitoring, beyond the compliance monitoring requirements. The goal of the extended monitoring is to allow all customers to easily determine lead levels and sources in their own household water, especially in cases where the household was not among the residences chosen for compliance monitoring. EPA expects this provision to increase substantially the effectiveness of the public education program in reducing exposure to lead in drinking water.

Under the extended monitoring requirement, water suppliers would be required to offer all customers the opportunity to have household water tested for lead. The public water supplier would not be required to provide this service for free, but would be allowed to pass the costs of gathering and analyzing the samples on to the customers who elected to participate in the program. The supplier itself could gather, analyze, and report the results to the customer, or the supplier could make arrangements with any certified laboratory to provide the analyses to the customer. In this way, customers would gain easy access to quality water sampling services, and not be subjected to repeated trial-and-error in finding reasonably priced, qualified sampling services. At the same time, the public water supplier could minimize its burden in providing the sampling services by making arrangements with an outside laboratory.

EPA strongly recommends that water suppliers assist customers in identifying the sources of high water lead levels when they are found. The supplier could advise customers to collect samples representative of water that has stood in the service line overnight and a fully flushed sample from the tap. Comparison of the service line sample with the fully flushed sample would allow the customer to identify the source of elevated water lead levels and to take appropriate steps to effectively limit further exposure. For example, if the service line sample shows elevated lead levels, a lead service line may be present. The customer would then be able to determine the value of service line replacement as a means of reducing exposure.

If the alternative of having the public water supply remove lead service lines that it owns and/or controls and offer to remove the remainder for the customer at cost (as discussed below) is adopted, these additional samples would enable suppliers to determine which service lines must be replaced. If the fully flushed sample shows elevated lead levels, this would indicate that the lead is entering the house from the water supply either in the distributed water leaving the plant or as a result of corrosion of pipes owned or under the control of the water supplier. If only the morning first draw sample showed elevated lead levels, the customer could be fairly confident that the lead was originating within his/her residence.

EPA believes that the appropriate medium for public education and schedule for delivery of a public education program are largely a function of the target population. Thus, under this proposal, systems would be required to tailor the form of delivery of the public education program to the nature and size of the target population. For instance, if the target is all residents of a large city, a radio or television Public Service Announcement (PSA) would be appropriate. Conversely, if the target is all residents of a single neighborhood or small town, a public meeting in the neighborhood school would be appropriate. Some other possible methods for public education include preparation of pamphlets or brochures for mass distribution and setting up local telephone hotlines (if used in conjunction with other education methods). The severity of the high lead levels is another factor systems should consider in determining the appropriate medium of education and intensity of the program.

Non-transient non-community water systems serve different populations than community water systems, and thus have different public education requirements. Instead of the requirements described above, NTNC

water systems would be required to take the following actions for the duration of the period during which public education is required: (1) Publicly post informational posters in a prominent place; (2) hold at least one public meeting annually to educate water consumers about lead in drinking water and to answer questions about the subject; and (3) distribute brief informational pamphlets on lead in drinking water at least quarterly.

Public water systems serving more than 3,300 persons would be required to submit the proposed content of the public education program, as well as the manner in which the system would implement it, to the State for review and approval before implementation as a part of the treatment plan. In order to speed implementation of public education, States could approve the part of the treatment plan which covers public education before approving the rest of the treatment plan.

As with public notification requirements, public education programs are the responsibility of the water supplier. However, recognizing that not all systems would have the expertise to conduct such a program in an effective manner, EPA encourages systems to develop joint agreements with State or local public health agencies which have experience in presenting information on health hazards to the public. EPA also encourages systems to coordinate their activities with other local or State programs designed to reduce exposure to lead. For example, local childhood lead screening programs may include complementary public education activities.

Under this proposal, a public education program would include a series of events. For example, a single effort could include several public meetings, a series of PSAs, and a mailing of pamphlets. This series of events could occur over a period of time (e.g., several weeks). The public education program, consisting of each of its individual events, would be required to occur at the rate of four times per year for as long as the system is required to conduct a public education program (i.e., as long as one of the two lead no-action levels is exceeded). For example, a note could be placed on each water bill that says "Are you aware of the possible effects of lead in your drinking water? You should be. Contact _____ for more information."

iii. *Program Evaluation.* Under this proposal, a water system which serves more than 10,000 customers and conducts a public education program would be required to evaluate the program, within 12 months after the program is undertaken, to determine the extent to which it has been effective. The system must show that consumers have knowledge about lead in drinking water. The evaluation would consist of a survey of customers to determine whether they had acquired useful information that enabled them to reduce their exposures to lead in drinking water. Based on this evaluation, the system would determine if and how the program would be modified to increase the program's effectiveness if modification is determined by the State to be necessary to ensure the program's continued effectiveness.

3. Alternatives to the Proposed Treatment Technique

The SDWA requires EPA to set NPDWRs as close to the MCLG as is feasible. EPA believes the proposed rule meets this standard and also is protective of public health. However, EPA is considering several alternatives in addition to the proposed rule. They are discussed in detail below. EPA may decide to promulgate a rule which incorporates any one or more of these alternatives. For example, EPA may retain the average lead no-action level and eliminate the pH no-action level, and delete the MCL for lead in distributed water. Alternatively, EPA may modify the proposal by having the maximum lead no-action level trigger treatment, requiring replacement of those lead service connections which contribute significant amounts of lead to tap water, and/or adopt an alternative approach to monitoring. Accordingly, the Agency especially requests comments on each of these alternative approaches and combinations of alternatives.

a. *Use of Maximum Lead No-Action Level to Trigger Treatment.* EPA is considering an alternative to the proposal which would likely result in lead levels in water somewhat closer to the proposed goal of zero. This alternative is similar to the proposal except that corrosion control treatment in addition to public education would be triggered if the lead level in more than 5 percent of the samples exceeded 0.020 mg/l. Systems that did not meet this additional no-action level would be required to reduce the corrosivity of water until it no longer exceeded this level or demonstrated to the State that it had minimized the corrosivity of its water, in addition to conducting public education. (Under the proposed rule, systems failing to comply with the no-action level of 0.020 mg/l or less in 95 percent or more of samples would be subject to the public education requirement only.)

EPA expects that some systems that meet the average lead no-action level would not be able to meet the maximum. Thus, more water suppliers would be required to install or improve corrosion control treatment, and to demonstrate to the States that the treatment they had installed resulted in compliance with the no-action levels or was optimal. Two groups of water suppliers would be affected in this way. Some water suppliers that would meet the proposed no-action level average of 0.010 mg/l without any treatment or additional treatment (beyond that already in place) may fail to meet the "maximum" of 0.020 mg/l. In addition, water suppliers that would already be required under the proposal to improve water treatment to meet the average of 0.010 mg/l might have to improve their treatment more if they must try to meet both the average and the "maximum" of 0.020 mg/l. If they could not meet both levels, they would be required to demonstrate that the water is minimally corrosive. EPA is unable to precisely estimate the increased number of water suppliers that would be affected but it is likely to be several thousand.

Since more systems would be treating their water to make it less corrosive than under the proposed rule, more people would consume water with less lead than under the proposals (although precise estimates of these reductions are not available). EPA seeks comment on this alternative because this alternative would result in water lead levels closer to the MCLG of zero, thus reducing consumers' exposure to lead more than the approach proposed today. This reduced exposure would result in some additional health benefits with potential theoretical benefits under this alternative that could be substantial. However, EPA is concerned that many more water suppliers may have to demonstrate to the State that they have optimized corrosion control or that new or improved treatment results in meeting the no-action levels. It is unclear whether the States would be able to sustain a time-consuming and technical interaction with an increased number of facilities over several years while at the same time assuring effective implementation of the other drinking water regulations. Therefore actual benefits may be less than the theoretical benefits and may not be substantially different than the proposed alternative. Because of this concern, EPA is also considering two variations to this alternative which may reduce the magnitude of this implementation

problem. The first is raising the maximum no-action level to trigger corrosion control treatment to 0.030 mg/l to better assure that this alternative could be implemented while still providing additional health benefits by limiting high lead exposures. The second variation would substitute the no-action level of 0.020 mg/l or less lead in 95 percent or more sample in place of the two no-action levels in the proposal (average level of 0.010 mg/l for lead and pH >8 in 95 percent or more samples) and have only one no-action level to trigger both corrosion control treatment and public education. EPA requests comment on all of these alternatives.

b. *Use of Total Alkalinity No-Action Level to Trigger Treatment.* EPA is considering an alternative to the proposal which would likely result in lead levels in water somewhat closer to the proposed goal of zero. This alternative is similar to the proposal except that corrosion control treatment would be triggered if the total alkalinity in 95 percent or more samples was not 30 mg/l or higher. Systems would be required to reduce the corrosivity of water until it exceeded this level or demonstrated to the State that it had minimized the corrosivity.

EPA expects that some systems that meet the average lead no-action level and the no-action pH level would not be able to meet the total alkalinity no-action level. Thus, more water suppliers would be required to install or improve corrosion control treatment, and to demonstrate to the States that the treatment they had installed resulted in compliance with the no-action levels or was optimal. Two groups of water suppliers would be affected in this way. Some water suppliers that would meet the proposed no-action level average of 0.010 mg/l lead and the no-action level for pH without any new or additional treatment (beyond that already in place) may fail to meet the total alkalinity no-action level of 30 mg/l. In addition, water suppliers that would already be required under the proposal to improve water treatment to meet the average of 0.010 mg/l and/or the pH >8 might have to improve their treatment more than necessary to meet the average and the pH only to try to meet the total alkalinity of 30 mg/l. If they could not meet all three levels, they would be required to demonstrate that the water is minimally corrosive. EPA is unable to precisely estimate the increased number of water suppliers that would be affected but it may be about a thousand.

Since more systems would be treating their water to make it less corrosive than under the proposal, more people would consume water with less lead than under the proposal (although precise estimates of these reductions are not available). This alternative would result in water lead levels closer to the MCLG of zero, thus reducing consumers' exposure to lead more than the approach proposed today. EPA seeks comment on this alternative because this reduced exposure would result in some additional health benefits with potential theoretical benefits under this alternative that could be substantial. Actual benefits may be less than the theoretical benefits and may not be substantially different than the proposed alternative. However, EPA is concerned that more water suppliers may have to demonstrate to the State that they have optimized corrosion control. If average lead levels are equal to or below 0.010 mg/l, but the alkalinity fails to meet the specified level, additional treatment may not substantially reduce lead levels further. Therefore, including alkalinity may cause some systems to incur additional costs unnecessarily. EPA solicits comment on this alternative.

c. *Eliminating the pH No-Action Level.* The proposed regulation would require that water suppliers adjust the pH of their water to 8 or above, unless they demonstrate that corrosion is minimized at lower pH levels, as part of the corrosion control treatment technique. EPA believes this parameter represents the outer bound of water that is minimally corrosive to lead. However, concern with using pH as a fixed regulatory requirement has been raised. If average lead levels are equal to or below 0.010 mg/l, but the pH fails to meet the specified level, additional treatment may not substantially reduce lead levels further. Therefore, including pH may cause some systems to incur additional cost unnecessarily.

Because of this concern, EPA solicits public comment on an alternative in which the pH value is not a regulatory no-action level but only guidance. Under this alternative, determination of compliance with the treatment technique requirement would be based solely on the lead and copper levels found in the sampled residences. The MCL of 0.005 mg/l for lead in water leaving the treatment plant would still apply, as would the MCL of 1.3 mg/l for copper. If samples exceed the average of 0.010 mg/l, the PWS would be required to install corrosion control treatment and conduct a public education program as in the proposed rule. Those systems that continue to exceed the 0.020 mg/l lead no-action level in more than five percent of targeted samples must also conduct public education. Once lead was reduced to below the 0.010 mg/l average, or the water supplier demonstrated that optimal corrosion control treatment was being applied, the water supplier would be in compliance with the treatment technique requirement.

Under this alternative, suppliers would not be required to measure pH as part of compliance monitoring. However, systems that did not meet the no-action average level for lead would be required to monitor pH and examine the effects of increasing pH above 8 as part of the optimization demonstration.

This alternative could result in less public health protection because fewer systems may be required to install corrosion control treatment. The pH requirement, in conjunction with the lead average no-action level, would trigger treatment in more systems than would the lead average alone. In addition fewer small systems may be required to install treatment under this alternative because these systems are required to take fewer lead and copper samples. Because of the reduced monitoring, more of these systems are likely to have undetected lead levels above the no-action level and thus would not be required to install or improve treatment; the pH no-action level "catches" some of these systems and requires them to control corrosion. Thus final lead levels may not be as close to the proposed MCLG of zero as under the proposed approach.

Note that the actual reduction in benefit in this alternative may be somewhat smaller than the theoretical reduction because it is easier to administer. Therefore, the actual benefits may not be substantially different than the proposed approach.

Theoretically, one way to overcome this problem with this alternative would be for EPA to increase the number of lead samples required by PWSs, especially small systems. However, EPA is concerned that small systems may be unable to take the additional number of samples necessary to assure protection of public health. EPA is especially interested in comment on the trade-off between the proposal and improving this alternative by increasing the number of samples required.

d. *Lead Service Line Replacement Program.* EPA considered requiring replacement of lead service lines and connections in cases where they contribute measurable amounts of lead to the tap water, but is not now proposing this program. EPA particularly solicits public comment both on the specific alternative described below including the materials evaluation and

monitoring requirements, as well as any alternatives that might better achieve EPA's goals in a better and less burdensome way.

The program EPA is considering would require the replacement of lead service lines and connections that, after implementation of any corrosion control treatment, continue to contribute measurable amounts of lead to drinking water (0.003 mg/l or more), and that are under the ownership or control of the PWS. This alternative would have three components: (1) A full materials evaluation (i.e., identification of all buildings served by lead service lines or connections), (2) monitoring at all buildings with lead service lines or connections, and (3) the replacement of lead service lines and connections under the ownership or control of the system that are found to contribute 0.003 mg/l or more to lead levels at the tap. Obviously, no such program would be required in communities in which no lead service lines or connections have been used.

The program considered by EPA would require replacing only those pipes that contribute measurable amounts to lead levels at the tap. Communities that have residences with lead service lines in their targeted sample set (as described in Section V.C.2.) would be candidates for the lead service line replacement program. If the service line sample of any house in the targeted monitoring set exceeded 0.020 mg/l, the system would be requried to identify and take service line samples from a number of residences equal to the number of required samples for compliance monitoring. If five percent or more of the total service line samples from this expanded sample exceeded 0.020 mg/l, the service line replacement program would be triggered for that system.

Once the service line replacement program was triggered, the system would be required to take the three steps listed above: inventory all lead service lines and connections in the community, test each of them, and replace all portions of those connections owned or controlled by the system contributing measurable amounts of lead to the drinking water.

Under this program, EPA would establish two rebuttable presumptions. The first rebuttable presumption would be that lead service lines and connections contribute to lead levels at the tap. The water supplier would first be required to conduct a full inventory of the materials used in the water system and to locate all lead service lines, goosenecks, pigtails, and other lead materials. A materials evaluation should already have been conducted under the requirements of the 1980 amendments to the National Interim Primary Drinking Water Regulations (45 FR 57332, August 27, 1980, 40 CFR 141.42(d)). If not previously done, suppliers would be required to conduct a complete materials evaluation. To rebut the presumption and avoid replacing the lead service lines and other connections, the PWS would be required to monitor each home in the community with a lead service connection or pipe to determine whether the lead service contributes measureable amounts of lead to lead levels at the tap. Specifically, the PWS would have to take a service connection sample and fully flushed sample and demonstrate that the service connection sample has lead levels that are no more than the fully flushed sample from the same tap. This presumption must be rebutted for each lead connection the system wishes to avoid replacing.

The second presumption is that the water supplier owns or controls and therefore can replace, the lead components up to the wall of the building served. In this case, the PWS would be required to replace the entire length of each lead service connection contributing measurable lead to water, from the water main to the building wall, including lead goosenecks, pigtails, and any other lead connections. This presumption could be rebutted by the water supplier by citing local ordinances or State statutes, or in the case or private suppliers, the contract between the system and their customers, that might limit the extent of the PWS' control. Water supplies that rebut the second presumption would have to replace only the portion of each service line and those connections under their ownership or control that contribute a measurable amount of lead to the water.

Lead service connections would be required to be replaced on a fixed schedule as part of the system's treatment plan. No water supplier would be allowed longer than 15 years (starting when the service connection replacement program is triggered unless the system is granted an exemption under Section 1416 of the Act) to replace all lead service connections that require replacement. Water suppliers would be required to replace, or test and rebut the presumptions, for a number of lead services equal in number to at least five percent of the total service connections in the community each year until all those requiring it are replaced. EPA would set the 15-year time limit because this schedule accelerates replacement over current practice.

e. *No MCL for Distributed Water.* Instead of the proposed two-part approach consisting of MCLs for lead and copper in distributed water and a treatment technique for lead and copper as corrosion by-products, EPA considered an alternative which would establish only a treatment technique for those contaminants which can enter water from source water and as a by-product of corrosion. The alternative would resemble the proposed approach except there would be no MCL for lead and copper in distributed water. Under this alternative, systems meeting the no-action level average of 0.010 mg/l and having 0.020 mg/l or less lead in 95 percent of targeted samples, and having 1.3 mg/l or less copper in 95 percent of targeted samples would be in compliance with the treatment technique requirement.

A system not initially meeting the lead average or copper no-action levels would be allowed to employ whatever combination of corrosion control and source water treatments the system chooses to meet the no-action level. Systems still failing to meet the no-action levels by the specified date (either due to source water or corrosion problems) would be required to obtain a State-approved treatment plan. The treatment plan would contain two elements: (1) Steps to reduce lead levels to below the no-action levels or to demonstrate that source water controls and corrosion control treatment are optimal if the no-action average lead level of 0.010 mg/l were not met, and (2) a public education program if the lead average were not met or if five percent of lead samples exceeded 0.020 mg/l. Under this alternative, systems would generally be required to take the following steps to reduce the lead levels in water:

(1) Conduct a study to determine the amount of lead in morning first draw samples that originates in the source water and the amount originating as a corrosion by-product, in the residences monitored for compliance (monitoring would be conducted in targeted residences, as in the proposed rule).

(2) If lead in source water was found to be above 0.010 mg/l, the system would be required to install lead removal technology including any of those that would remove lead from source water to below 0.010 mg/l is described as BAT in Section IV.C. above.

(3) If lead as a corrosion by-product was found to be above 0.010 mg/l as an average, the system would be required to install corrosion control treatment, as described in Section IV.D.1. above.

(4) If neither source water lead nor corrosion by-product lead were individually above 0.010 mg/l (either naturally or because of treatment installed in (2) or (3) above), but the combination of them was above 0.010 mg/l, the system would be required to install either lead removal treatment as described in (2) above, or corrosion control treatment as described in (3) above, or both. The precise combination chosen would be up to the system, as long as the levels in targeted samples were reduced to 0.010 mg/l or lower as a average. If, after installation of treatment, average lead levels in targeted samples remain above 0.010 mg/l, systems would be required to install any additional treatment required by the State (either lead removal or corrosion control treatment), or if none existed, demonstrate to the State that treatment (especially corrosion control treatment) already installed was being operated in a manner that minimized lead levels.

(5) If, after installation of all the treatment described in (2)–(4) above, morning first draw lead levels remained above an average of 0.010 mg/l or if lead levels are 0.020 mg/l or less in 95 percent of targeted samples, the system would be required to conduct a public education program.

A potential advantage offered by this alternative is that it offers a PWS the opportunity to determine for themselves and implement the most efficient combination of treatments to minimize lead levels at the tap. A disadvantage of this option is that it would allow systems to distribute water at levels between 0.005 and 0.010 mg/l in cases where lower levels are possible.

V. Monitoring

A. Analytic Methods

1. Background

NPDWRs must include "criteria and procedures to assure a supply of drinking water which dependably complies with such maximum contaminant levels, including quality control and testing procedures to insure compliance with such levels and to insure proper operation and maintenance of the system * * * ." Section 1401(1)(D).

EPA evaluated the analytic methods for lead, copper, and pH with respect to the accuracy of recovery (lack of bias) and precision (good reproducibility) in the range of the MCLs and no-action levels being considered. The primary purpose of this evaluation was to determine:

- Whether analytic methods are technically available to measure these contaminants in drinking water;
- What are reasonable expectations of technical performance by analytic laboratories at the proposed MCL and no-action levels; and
- The costs of analysis for these contaminants.

The selection of appropriate analytic methods for compliance with these regulations includes consideration of the following factors:

- Reliability (i.e., precision/accuracy) of the analytical results;
- Specificity in the presence of interferences;
- Availability of sufficient equipment and trained personnel to implement a national monitoring program;
- Rapidity of analysis to permit routine use; and
- Cost of analysis to water supply systems.

2. Specific Analytic Methods

There are analytic methods available and approved by EPA for the determination of lead in drinking water, as listed in Table 10. There is no currently approved method for copper because there is currently no primary MCL for it. The analytic methods listed in this table have been used for many years to meet the compliance monitoring requirements specified in the interim NPDWR for lead.

TABLE 10.—CURRENTLY APPROVED METHODS FOR ANALYZING LEAD UNDER THE INTERIM REGULATIONS

Methodology	Reference (Method Number)		
	EPA [1]	ASTM [2]	SM [3]
Atomic absorption; furnace technique	239.2	D3559–78A or B	301A–II or III
Atomic absorption; direct aspiration	239.1		
Inductively coupled plasma	[4] 200.7A		

[1] "Methods of Chemical Analysis of Water and Wastes," EPA Environmental Monitoring and Support Laboratory, Cincinnati, OH (EPA–600/4–79–020), March 1979. Available from ORD Publications, CERI, EPA, Cincinnati, OH 45268. (The technique applicable to total metals must be used.)
[2] Annual Book of ASTM Standards, Part 31 Water, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.
[3] "Standard Methods for the Examination of Water and Wastewater," 16th edition, American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1975.
[4] "Inductively-Coupled Plasma Atomic Emission Analysis of Drinking Water," Appendix to Method 200.7, September 1985, U.S. EPA, Environmental Monitoring and Support Laboratory, Cincinnati, OH 45268.

Table 11 lists the analytic methods that EPA is proposing today for compliance with the copper MCL, revised lead MCL, and treatment requirements for both lead and copper described in this proposed rule. EPA is proposing to approve neither the atomic absorption direct aspiration technique nor the inductively coupled plasma technique for measuring lead to determine compliance with today's proposal because the method detection limits for these two techniques are too high to determine the low concentrations of lead in drinking water proposed in this rule.

TABLE 11.—PROPOSED METHODS FOR ANALYZING LEAD AND COPPER

Contaminant	Methodology	Reference (Method Number)			
		EPA [1]	ASTM [2]	SM [3]	Other
Lead	Atomic absorption; furnace technique	239.2	D3559–85D	304	
Copper	Atomic absorption; furnace technique	220.2	D1688–84F	304	
	Atomic absorption; direct aspiration	220.1	D1688–84D or E	303A–A or B	

TABLE 11.—PROPOSED METHODS FOR ANALYZING LEAD AND COPPER—Continued

Contaminant	Methodology	Reference (Method Number)			
		EPA [1]	ASTM [2]	SM [3]	Other
	Inductively coupled plasma	[4]200.7A			

[1] "Methods of Chemical Analysis of Water and Wastes," EPA Environmental Monitoring and Support Laboratory, Cincinnati, OH (EPA-600/4-79-020), Revised March 1983. Available from ORD Publications, CERI, EPA, Cincinnati, OH 45268. (For approved analytical procedures for metals, the technique applicable to total metals must be used.)

[2] Annual Book of ASTM Standards, Vol. 11.01, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

[3] "Standard Methods for the Examination of Water and Wastewater," 16th edition, American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1985.

[4] "Inductively-Coupled Plasma Atomic Emission Analysis of Drinking Water," Appendix to Method 200.7, September 1985, U.S. EPA, Environmental Monitoring and Support Laboratory, Cincinnati, OH 45268.

EPA has determined that the analytic methods listed in Table 11 are technically and economically feasible for routine use in compliance monitoring for lead and copper. The costs associated with the analysis of these metals are within the economic means of water supply systems. The cost for analyzing lead and copper is estimated at about $6 to $30 per metal per sample. (The actual analytical costs may vary with the laboratory, analytical technique selected, the total number of samples, and other factors.) Also, the number of laboratories that routinely participate in EPA's Water Supply and Water Pollution performance evaluation studies indicates that there are many laboratories available that have the capability to analyze for lead and copper in drinking water using these methods.

Below is a description of each of the techniques EPA is proposing to approve for analysis of lead and copper in drinking water. EPA requests public comment on the technical adequacy as well as the economic feasibility of the proposed analytic techniques.

a. *Atomic Absorption Methods.* Levels of lead and copper in solution may be determined by atomic absorption (AA) spectroscopy. There are two techniques that may be used: Direct aspiration and the furnace technique. EPA is proposing to allow use of the direct aspiration technique only to analyze for copper because this method cannot analyze the low levels of lead specified in this proposal. In direct aspiration, the sample is aspirated into a flame and atomized. A light beam is directed through the flame into a monochromator and onto a detector that measures the amount of light absorbed by the atomized element in the flame. Because each metal has its own characteristic absorption wavelength, a source lamp composed of that element is used which makes the method relatively free from spectral or radiation interferences. The amount of energy of the characteristic wavelength absorbed in the flame from the metal being analyzed is proportional to the concentration of the element in the sample. In the furnace technique, a sample is placed in a graphite tube in a furnace, evaporated to dryness, charred, and atomized. Because the percentage of available analyte atoms vaporized and dissociated for absorption in the graphite tube is greater using this method than the percentage of available analyte atomized in the flame of the direct aspiration AA method, the furnace technique can detect lower concentrations.

Low-level analyses of lead in drinking water using atomic absorption methods must be performed with uncontaminated glassware. Retained lead is most likely to occur on the ground glass surface of volumetric glassware. EPA recommends that laboratories avoid the problem of contamination by using a separate set of glassware for low-level lead analyses. Also, particular attention should be given to glassware cleaning by ensuring that all ground glass surfaces are soaked and held in contact with cleaning acid for a minimum of two hours.

b. *Inductively Coupled Plasma (ICP)—Atomic Emission Spectrophotometric Method.* This method (also known as "EPA Method 200.7") describes a technique for the simultaneous or sequential multi-element determination of trace elements in solution. This method is applicable to the measurement of copper only; it is not yet sensitive enough to measure lead for purposes of this regulation. (Further improvement in the method may make it appropriate for measurement of lead at a later date. If so, EPA would then consider approving this method for measuring lead.) The basis of the method is the measurement of atomic emission by an optical spectroscopic technique. Samples are nebulized and the aerosol that is produced is transported to the plasma torch where excitation occurs. Characteristic line emission spectra are produced by a radio frequency inductively coupled plasma (ICP). The spectra are dispersed by a grating spectrometer and the intensities of the lines are monitored by photomultiplier tubes. The photocurrents from the photomultiplier are processed and controlled by a computer system. A background correction technique is required to compensate for variable background contributions to the determination of trace elements. Background levels must be measured adjacent to analyte lines on samples during analysis.

The appendix to EPA Method 200.7, entitled "Inductively Coupled Plasma—Atomic Emission Analysis of Drinking Water," describes a technique for concentrating the sample prior to analysis. Under this proposal, systems would be required to follow this concentration technique in processing drinking water supply samples prior to ICP emission spectrometric analysis for copper.

3. *Method Detection Limits and Practical Quantitation Limits*

Generally, EPA defines the method detection limit (MDL) as the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the true value is greater than zero. The practical quantitation limit (PQL) is the lowest concentration that can be reliably achieved by well-operated laboratories within specified limits of precison and accuracy during routine laboratory operating conditions. Differences between the MDLs and PQLs are expected; the PQL is generally about 5 to 10 times the MDL for relatively clean matrices such as finished drinking water. (See EPA 1987e, and 50 FR 46902, November 13, 1985, for a detailed discussion of MDLs and PQLs.)

The PQL may be determined through interlaboratory studies, such as performance evaluations (PE) studies. However, if data are not available from interlaboratory studies, the PQLs may be estimated. In such cases, EPA believes that a PQL set at 10 times the MDL achieved by good laboratories is generally a fair expectation for routine operation of most qualified State and

commercial laboratories. The use of "five times the MDL" instead of "10 times the MDL" to set the PQL may be appropriate when other considerations suggest that the PQL should be lower, e.g., see discussion of the PQL for vinyl chloride in the final NPDWRs for volatile organic chemicals, July 8, 1987 (52 FR 25690).

Detection limits have been estimated for the available analytical techniques for lead and copper and are summarized in Table 12. Detection limits for lead and copper traditionally have been based on a concentration that corresponds to a specified instrument signal-to-noise ratio (i.e., peak height to background). The detection limits for ICP using the concentration technique (1 μg/l for copper and 0.005 mg/l for lead) were calculated based upon MDLs. The MDL approach involves the determination of method detection limits using a procedure defined in Appendix B to 40 CFR Part 136 (analytic methods for wastewater pollutants). EPA is using the MDL concept to calculate limits of detection for analytes in all newly developed methods for determination of drinking water contaminants.

TABLE 12. DETECTION LIMITS FOR AVAILABLE ANALYTICAL METHODS FOR COPPER AND LEAD

Contaminant	Proposed MCLG (μg/l)	Analytic method	Detection limit (μg/l)
Copper	1,300	Atomic absorption; furnace.	1
		Atomic absorption; direct aspiration.	20
		Inductively coupled plasma.	*6(1)
Lead	[illegible]	Atomic absorption; furnace.	1
		†Atomic absorption; direct aspiration.	[illegible]
		†Inductively coupled plasma.	*(5)

*Using the concentration technique in Appendix A to the EPA Method 200.7.

†EPA is not proposing to approve these methods for lead because the detection limits are too high to detect low concentrations of lead in drinking water.

The PQLs for lead and copper were determined based primarily upon the detection limits and the results from PE studies. The PQL for lead was determined using EPA and State laboratory data from Water Supply (WS) PE studies #12–17. The PQL for copper was determined using EPA and State laboratory data from Water Pollution (WP) PE studies #12–16, since copper is not included in WS studies. These results are considered to be optimum since they are drawn from experienced laboratories operating under conditions where they knew they were being tested, using standard samples in distilled water and without interferences. Actual day-to-day operations in a wide variety of laboratories using "real" samples of natural tap water would be expected to produce somewhat poorer results, i.e., have wider performance ranges, especially at the lower concentrations.

EPA used the following procedure to determine the PQLs for lead and copper using the PE study data:

1. Regression equations were generated for precision and accuracy using the EPA and State laboratory data for lead and copper.

2. The percent recovery and relative standard deviation were used to estimate the 95 percent confidence limits. The percent recovery and relative standard deviation were calculated at the proposed MCLG for copper using the regression equations generated from the laboratory data for the contaminant. For lead, the percent recovery and relative standard deviation cannot be calculated at the proposed MCLG because it is zero. Therefore, another concentration must be used to calculate the 95 percent confidence limits. This value is set as close as possible to the proposed MCLG. The lowest MDL for any of the methods used to detect lead is 0.001 mg/l (for the atomic absorption furnace method). The minimum PQL for this method is "five times the MDL" or 0.005 mg/l using the "five to 10 times the MDL" criterion. This value was selected as the appropriate concentration to calculate the 95 percent confidence limits from the regression equations. The percent recovery, relative standard deviation, and the 95 percent confidence limits for lead and copper are summarized in Table 13.

TABLE 13.—95 PERCENT CONFIDENCE LIMITS FOR DETECTION OF LEAD AND COPPER

Contaminant	MCLG (mg/l)	Percent recovery	Relative standard deviation	95 percent confidence limits (percent of true value)
Lead	[1] 0.005	107	21	65–149
Copper	1.3	99	[illegible]	91–107

[1] The calculations are made assuming that 0.005 mg/l is the lowest possible PQL instead of zero. For further explanation, see the discussion above.

Sources: USEPA 1983–1985, Water Supply PE studies #12–17 and Water Pollution PE Studies #11–16.

3. EPA and State laboratory data for each contaminant were evaluated to determine the limits for the "plus or minus percent of the true value" that most closely approximated the 95 percent confidence limits. They are summarized in Table 14.

TABLE 14.—PROPOSED ACCEPTANCE LIMITS FOR LEAD AND COPPER

Contaminant	MCLG (mg/l)	Acceptance limits (plus or minus percent of true value)	PQLs (mg/l)
Lead	[1] (0)0005	[illegible]	0.005
Copper	1.3	10	0.050

[1] The calculations are made assuming a minimum possible PQL of 0.005 mg/l instead of zero. For further explanation, see the discussion above.

4. The proposed PQLs for lead and copper were set based on the available data at a concentration where at least three-quarters of the EPA and State laboratories were within the specified acceptance range. These PQLs are summarized in Table 14.

Public comments are requested on the PQLs for lead and copper.

4. pH—Electrometric Method

EPA is proposing to approve the electrometric method for measuring the pH of drinking water samples collected to determine compliance with this proposed rule. The references for this method appear in Table 15 below. Under this method, the pH of a sample is determined electrometrically using either a glass electrode in combination with a reference potential, or using a

combination electrode. The pH meter must provide accurate and reproducible results within ±1 pH unit and should be equipped with a temperature compensation unit. The pH meter may need to be adjusted to compensate for water temperature. Samples should be analyzed in the field at the time of sampling.

TABLE 15. METHODOLOGY FOR ANALYZING FOR PH AND TOTAL ALKALINITY

Parameter	Methodology	Reference (Method Number)			
		EPA [1]	ASTM [2]	SM [3]	Other
pH	Electrometric	150.1	D 1293-84	423	
Total Alkalinity (as $CaCO_3$, mg/l)	Titrimetric	310.1	D 1067-82A	403	

[1] "Methods of Chemical Analysis of Water and Wastes," EPA Environmental Monitoring and Support Laboratory, Cincinnati, OH (EPA-600/4-79-020), March 1985. Available from ORD Publications, CERI, EPA, Cincinnati, OH 45268.
[2] Annual Book of ASTM Standards, Vol. 11.01, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.
[3] "Standard Methods for the Examination of Water and Wastewater," 16th edition, American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1985.

5. Total Alkalinity—Titrimetric Method

Under the titrimetric method, total alkalinity is measured by titration to an electrochemically determined end point pH of 4.5. The sample must not be filtered, diluted, concentrated, or altered in any way. The sample would be required to be refrigerated to 40°C and run as soon as practical. The sample bottle should be air tight and should not be opened before analysis. The pH measured at the tap must be provided with this sample so that an accurate alkalinity measurement can be made.

Under this procedure, the alkalinity is calculated using the following formula:

$$\text{Alkalinity, mg } CaCO_3/l = \frac{A \times N \times 50{,}000}{\text{ml sample}}$$

where:
A = ml standard acid used.
N = normality of standard acid.

For low alkalinities, the titration is stopped at a pH in the range of 4.3 to 4.7. The volume of titrant required to reach that pH and the specific pH are recorded. The sample is next titrated to a pH exactly 0.3 pH units lower and the volume of titrant required to reach this end point is recorded. (Method 403, Standard Methods for the Examination of Water and Wastewater, 16th edition, 1985).

For low alkalinities, total alkalinity is calculated by the following formula:

$$\text{Total alkalinity, mg } CaCO_3/l = \frac{(2B - C) \times N \times 50{,}000}{\text{ml sample}}$$

where:
B = ml titrant to first recorded pH.
C = total ml titrant to reach pH 0.3 units lower.
N = normality of standard acid.

B. Laboratory Approval

EPA recognizes that the effectiveness of the proposed regulations depends upon the ability of analytical laboratories to measure lead and copper reliably at relatively low levels. pH measurements must be reliable as well. EPA's regulations specify that only approved laboratories can analyze compliance samples (40 CFR 141.28).

EPA's existing drinking water Laboratory Certification Program (LCP) has established the use of external checks of performance to evaluate the ability of laboratories to analyze samples for specific contaminants and to produce data within specific limits. For this purpose, EPA provides performance evaluation (PE) samples to laboratories on a regular basis; participation in this program is a prerequisite for a laboratory to achieve certification and to remain certified for analyzing compliance samples. Achieving acceptable performance in these studies of known test samples provides some indication that the laboratory is following proper practices. Unacceptable performance may be indicative of problems that could affect the reliability of the compliance data generated for specific contaminants.

Unacceptable performance by any laboratory may trigger an investigation to establish the possible cause(s) and to take corrective action. EPA recognizes that even a superior analytical laboratory occasionally produces data that are outside the acceptable limits for statistical reasons rather than any actual analytic problem. A provision for rapid follow-up analysis if a laboratory fails the initial determination is necessary to decrease the likelihood of statistical error and to determine if a real problem exists.

EPA's present PE sample program and the approaches used in the determination of laboratory performance requirements were discussed at 50 FR 46907 (November 13, 1985). Acceptable performance has historically been set by EPA using two different approaches: Regressions from performance of pre-selected laboratories or specified accuracy requirements. EPA requested public comment on these approaches in the November 13, 1985 notice. Most commenters on that notice supported the use of a "plus or minus percent of the true value" approach to derive acceptance limits instead of generating performance requirements from study statistics. EPA agrees with these commenters that this is the best approach and will specify accuracy requirements in the revised regulations whenever possible.

1. Laboratory Performance for Lead and Copper

EPA has evaluated performance data gathered from past PE studies to set performance requirements for lead and copper analysis. The available PE data indicate that both the precision and the accuracy attained for specific inorganic contaminants are contaminant-specific. For example, the percent recoveries are 99 percent for copper and 107 percent for lead while the relative standard deviations are 4 percent for copper and 21 percent for lead. The "plus or minus percent of the true value" acceptance limits have been derived for each contaminant taking into consideration the expected precision and accuracy and using 95 percent confidence limits to estimate the acceptance limits. For example, the acceptance limits for copper using 95 percent confidence limits would be 99 percent ±2x (4 percent) or 91 to 107 percent of the "true value." Thus, a ±10 percent of the "true value" acceptance limit is approximately equal to the 95 percent confidence limits. The acceptance limits would apply to concentrations equal to or more than the PQL.

The acceptance limits are summarized below:

Contaminant	Acceptance limits
Copper	±10% at >0.050 mg/L
Lead	±30% at >0.005 mg/L

Public comments are requested on the acceptance limits for lead and copper.

2. Laboratory Performance for Total Alkalinity

The approval criteria for the pH analysis is different from all of the other approval criteria because pH analysis is done in the field. 49 FR 43234, Oct. 26, 1984. The pH analyses would be conducted in the targeted homes with a pH meter. The pH papers would not be permitted for this analyses. The pH meter must meet the specifications listed in the available methods (see Table 15). Under the proposal the pH analyses must be conducted by samplers who have been certified to use pH meters. This is especially necessary because exposure of the sample to air changes sample pH when the sample contains anions such as carbonate (EPA 1982). However, the analyses conducted on site may be limited by either a lack of certified samplers or a lack of pH meters. EPA requests comment on the pH approval criteria.

Therefore, EPA is proposing to allow systems which serve 3,300 persons or less collect the pH sample and send it to a certified laboratory for analysis. EPA is aware that this exception will often result in a systematic bias of the pH readings to more frequent misses of the no-action levels, and encourages systems to consider carefully the tradeoff between ease of analysis and analytical accuracy (EPA, Method 150.1, Methods for Chemical Analysis of Water and Wastes, revised March 1983). EPA requests comment on whether non-field testing of samples should be allowed for systems that serve fewer than 3,300 persons.

EPA is considering and taking comment on a requirement that water systems meet a specific alkalinity value in their water in addition to the proposed no-action levels. It is also critical to know the alkalinity of the water in order to determine the type and extent of appropriate corrosion control treatment. EPA therefore solicits public comment on the following laboratory certification requirements that would be necessary if the alkalinity requirement were adopted in the final rule.

Laboratories that meet the approval criteria for metal analyses would also be required to meet the performance requirements for total alkalinity analyses because, under the proposal, all of these analyses are required for samples taken from the targeted homes (as explained below), and EPA would require all analyses for a set of samples to be conducted at the same laboratory. EPA has evaluated performance data gathered from past PE studies to set the performance requirements for total alkalinity. However, the procedure for selecting the performance requirements is different than the procedure for the metal analyses because there is no MDL or PQL for the analysis of total alkalinity. Since laboratories must meet the approval criteria for total alkalinity in addition to the criteria for the metals, the percentage of laboratories that can achieve this criteria must be higher than that of the metals so that only a very few laboratories that pass the criteria for metals are eliminated because of a failure to meet the alkalinity criteria. Therefore, ±20 percent of the "true value" has been selected as the approved criteria for total alkalinity. In the data from the PE studies, at least 90 percent of the EPA and State laboratories are typically able to measure total alkalinity within ±20 percent of the true value when the active amount is greater than or equal to 30 mg/L.

C. Monitoring Protocols

As explained above, water suppliers would be required to monitor a variety of parameters in order to demonstrate compliance with the proposed rule. These parameters include lead and copper levels at entry points to the distribution system and at taps, and pH at taps. As described below, community and non-transient non-community water systems would have different monitoring requirements for determining compliance with the corrosion control treatment techniques of this proposal.

For the purposes of averaging, all lead levels measured between the PQL (i.e., 0.005 mg/L) and the MDL (0.001 mg/L) would be averaged for the compliance determination. All lead levels below the MDL of 0.001 mg/L would be reported as zero and averaged as such. Lead levels reported below an MDL larger than 0.001 mg/L would be reported as that MDL and averaged as such.

1. Monitoring for Compliance with the MCLs

Water suppliers would be required to sample water as it enters the distribution system after any treatment to determine compliance with the MCLs for lead and copper. Water suppliers relying solely on ground water would be required to take only one sample per year per entry point to the distribution system. Water suppliers relying on surface water as their source would be required to take one sample each quarter to account for seasonal variations in contaminant levels. Water suppliers with both surface and groundwater sources would be required to monitor quarterly all entry points to the distribution system. States would have the discretion to identify representative wells for sampling (if there is no treatment or blending) for systems with multiple wells drawing from the same aquifer.

For the first round of MCL monitoring (which would last one year), historical data meeting the monitoring requirements specified in the proposed rule could be used in lieu of new data if the historical data were collected in a manner consistent with the final regulations. The total number of samples could be reduced by the use of composite samples at the discretion of the State. Combinations of samples from up to five sources would be allowed. If the concentration in the composite sample indicates that one or more of the samples may exceed the MCL, follow-up sampling would be required at each sampling point in the composite.

Follow-up sampling would be required if the reported concentration of a five-sample composite exceeds the method detection limit. For copper, an accurate analysis of one-fifth of the MCL is not a problem. For lead, however, the method detection limit is equivalent to the detection limit for the furnace atomic absorption technique. Laboratories should determine their method detection limit for this method by the procedure listed in Appendix B to 40 CFR Part 136. Laboratories should be able to achieve a method detection limit of 0.001 mg/L and data should be reported down to this concentration. If a laboratory is unable to achieve an MDL of 0.001 mg/L or lower, then sample compositing would not be permitted.

If the result of one analysis exceeds the MCL for lead or copper, the system would be out of compliance and the procedures for public notification must be followed. However, States would have the discretion to allow one additional sample to be collected as soon as possible (not to exceed two weeks from the date of the initial sample) at the same sampling location to verify the original results. In this case, if the average of the two samples analyzed exceeds the MCL, the system would be out of compliance and procedures for public notification must be followed. If the average is less than

the MCL, the system would be in compliance, the first sample results not withstanding. Systems exceeding the MCL would be required to sample more frequently than the minimum federally mandated requirements. The State must specify the increased monitoring frequency.

For community water systems, if there have been no violations for the most recent two years of monitoring, States could reduce the standard monitoring requirements to as infrequently as once every five years for systems serving fewer than 500 persons and any system serving 500 or more persons which is supplied only by ground water. For systems using surface water sources or a combination of surface and groundwater and serving more than 500 persons, monitoring could be reduced to once per quarter for one year, repeated every five years. No reductions in monitoring would be allowed for non-transient non-community water systems.

All systems would be required to begin monitoring to determine compliance with the MCLs according to the schedule in Table 16.

Table 16.—Starting Dates for Monitoring

System size	Monitoring to begin no later than—
>3,300	3 months after publication of final rule.
500–3,300	15 months after publication of final rule.
<500	27 months after publication of final rule.

EPA is phasing in the monitoring by system size in the same manner it has in previous NPDWRs to give systems time to learn about and implement the new requirements and to ease the burden on analytic laboratories which may not be able to cope with a sudden increase in the number of samples requiring analysis.

2. Monitoring for Compliance with the Corrosion Control Treatment Technique Requirement

Compliance with the corrosion control treatment technique requirement would be determined based on pH, lead, and copper levels at the tap. All systems would be required to begin monitoring for compliance with the treatment technique according to the schedule in table 16. Monitoring for each of these parameters at a targeted set of sample sites (see Section IV.C.2.a.i. for a discussion of how sites are to be selected) would be required quarterly for systems serving more than 3,300 persons, and less frequently for smaller systems. States may reduce monitoring frequency for systems serving more than 3,300 persons once compliance is established. Because the lead and copper no-action levels are measured as average and 95th percentile values, compositing is not allowed for samples collected to determine whether the no-action levels are met.

Values for pH are not expected to vary throughout the day at any given location, although they may vary among locations. However, lead and copper levels at the tap do vary considerably depending upon a variety of factors, including the standing time of the water in the plumbing pipes. Determination of whether the no-action levels were met would be determined by morning first draw and service connection samples. A morning first draw sample is the first sample taken after water has stood in the building's plumbing overnight, or for 8–18 hours, without flushing. (Flushing means running the water without capturing the water for sampling.)

A service connection sample is a sample of water that has been standing for 8–18 hours in the building service connection (service line and other connections). Service connection samples may be collected by several methods. One is to flush the tap until there is a temperature change (decrease) in the water. The colder water is that which has stood outside the house in the service connection. Another method is to measure pipe length and diameter from the tap to the service line and flush the volume estimated to be contained in the household plumbing before the service connection. Once the house water is flushed, the service connection sample is collected. A final method of collecting a sample representative of a service connection is to insert a sampling tap in the service line. However, this last method has the disadvantage of scraping bare a portion of the metal surface. This bare surface may result in temporarily high lead levels.

Morning first draw samples and service connection samples must be one liter in volume and collected at the cold water kitchen tap of targeted residences. Systems which have lead service connections would have to collect one half the required number of samples connection.

EPA expects that for community water systems the residences sampled would generally be single-family houses, but systems could include apartments and other multiple-family housing where such housing constitutes more than 20 percent of the housing served by the community. For non-transient non-community water systems, a morning first draw sample would be required from the tap or other outlet typically used to draw water for human consumption, in each building served by the NTNC system. The rationale for these requirements is as follows:

- One of the important determinants of lead and copper levels in drinking water is the standing time of the water in plumbing pipes. Water that has not stood in the pipes (i.e., fully flushed water) will generally have the lowest lead and copper levels of any sample taken at that tap. Water that has stood in the pipes for long periods will have higher lead and copper levels; water standing in pipes 8–18 hours ("standing samples") represents the highest levels that will routinely be found in drinking water. Standing samples would be required for several reasons. First, monitoring of water standing overnight, or some other specific long standing time (i.e., 8–18 hours), provides a consistent basis for measuring the progress of corrosion control treatment towards reducing levels of lead and copper. Standing samples represent the high end of actual human exposures are variable and are not known precisely (because people drink water from a variety of sources and also water that has a variety of standing times), actual exposure to lead and copper via drinking water will generally be no higher than levels found in standing samples.
- Sample volume also has an important effect on lead and copper levels in standing samples. The first 100 milliliters or so can have high levels from leaching lead out of faucets because lead is used in the manufacture of brass and bronze, which are often used in faucets and fittings. The next 400–500 milliliters represent water standing in the pipes near the faucet, and also may have high lead levels because of the numerous lead soldered joints that can lead up to the faucet (Lassovszky, 1984). Taking a one-liter sample represents less extreme lead levels than those generally found in a smaller sample because the initial high concentrations will be diluted by the later part of the sample, which contains lower concentrations. Because of the variation in lead levels with sample volume, EPA is proposing one liter as the standard sample volume for all samples.

Although nearly all the data provided to EPA by systems has been collected from one-liter samples, the question of the cost of shipping one-liter bottles to the laboratory has been raised to EPA. One approach to reduce the weight and bulk would be to collect 500-ml samples

instead. However, 500-ml samples will generally show a higher proportion of lead concentration from the faucet and a lower proportion from far and nearby lead soldered joints, than will 1 liter samples. However, because it is unlikely that an individual would consume an entire liter of water represented by a standing sample, EPA requests comment on an alternative sample volume of 500 ml. This alternative may better reflect a typical exposure. EPA estimates that 500 ml samples will show consistently higher concentrations of lead and copper than 1 liter samples, thus increasing the relative protectiveness of the proposed rules.

An alternative approach to lower the weight would be to collect one-liter samples and transfer a 500-ml aliquot to another bottle for shipment and analysis. The Agency is reluctant to adopt this approach because lead adheres to containers very easily. This increases the probability of sampling error and would likely show a consistent, unacceptable downward bias. The Agency solicits comment on this potential problem and possible approaches for minimizing it.

a. *Location of Sampling Sites.* Because the likelihood of high lead and copper levels in drinking water is not randomly distributed among buildings served by a given public water system, EPA is proposing that monitoring for compliance with the treatment technique requirement be targeted to residences most likely to have lead problems. Targeting for copper is not necessary because, in targeting for lead, copper corrosion problems should be identified simultaneously. Lead, copper, and pH would all be measured at the same set of residences. Systems would be required to identify a sampling pool that includes 50 percent more sites than the number required for monitoring each monitoring period (which varies by system size), to ensure that systems can get access to an adequate number of sites. The specific residences to be actually sampled would be selected randomly from the targeted set of residences. Once the system monitors the minimum number of sites, it would be required to use them every monitoring period. If one or more of these initial sites is no longer accessible, the system may, with State concurrence, substitute an alternative monitoring point from its sampling pool with the same characteristics as the initial point.

i. *Targeted Monitoring and Materials Evaluation.* To ensure that systems sample residences most likely to experience elevated levels of lead in tap water due to corrosion, water suppliers first would be required to conduct a materials evaluation to identify an adequate number of these high risk residences for monitoring. High risk residences are defined to include those that are at the ends of the distribution system and either: (1) Have lead service connections and/or lead interior plumbing; or (2) have lead solder that is less than five years old. "Ends of the distribution system" means those areas of low or no flow, sometimes known as "dead-ends." In communities where lead service connections are present, the group of residences selected would be required to include an equal number of residences for morning first draw and service connection samples. By targeting high risk residences for lead sampling, EPA believes that the monitoring would be more likely to identify high lead levels in communities where they exist, thus better assuring a high degree of public health protection. Targeting also would reduce the number of samples required to provide this level of public health protection.

To conduct the materials evaluation and identify sites for targeted monitoring, each system would be required, at a minimum, to consider the information identified by the State pursuant to 40 CFR 141.42(d). As necessary, the system must consider:

(A) Plumbing codes, permits, and records in the files of the community building department that indicate the plumbing materials installed within residences, including:

- Lead in piping, solder, caulking, interior lining of distribution mains, alloys, and home plumbing;
- Copper in piping, alloys, service lines, and home plumbing;
- Galvanized piping, service lines, and home plumbing.

(B) Inspections and records of the distribution system that indicate the material composition of the distribution lines, service lines, and connections.

(C) Existing water quality information, including results of prior analyses of water in the system or from individual residences, indicating residences in which the lead level of the water may be of concern.

(D) Design plans of the distribution system indicating residences that are served by the ends of the distribution system (i.e., areas of low or no flow).

The evaluation could be conducted based on building permits and other records, inspections of the distribution system and buildings, information from customers, or other means that reliably characterize the materials used in the construction of the distribution system and plumbing in buildings served. In conducting the materials evaluation, the system would not be required to examine every building served for the presence of lead materials.

Water suppliers that assert that there are insufficient residences in either of the two targeted categories (residences at the ends of the distribution system with either (1) lead service connections and/or lead interior plumbing, or (2) lead solder less than five years old) would be required to document this assertion to the State as follows:

1. *Lead service connections and interior plumbing.* The system would document via the materials evaluation that lead services, goosenecks, pigtails, or interior lead piping were never used in portions of the community served by the ends of the system or have all been replaced. If this could not be determined by records, the system would be required to inspect the service lines and connections, and interior plumbing, of all housing and other buildings constructed before 1940 (few lead service lines were used after this date) and show that no service lines or connections, or interior plumbing, are composed of lead or lead-containing materials.

2. *Lead solder.* The system would demonstrate that the State or community has had in effect and has consistently and successfully enforced a ban on lead solder use comparable to the Federal ban for five years, or that no lead solder was ever used in construction or residences and other buildings in the community served by the ends of the distribution system.

If the public water system could not identify a sufficient number of residences that have the required characteristics, the public water system would be required to demonstrate this to the State as described above and add to the sampling pool, as equally distributed as possible, residences that either: (1) Contain lead solder that is less than five years old; or (2) are serviced by lead service connections, as appropriate. If the public water system still could not establish a sampling pool sufficiently large to meet the monitoring requirements of this section, the public water system would be required to add to the sampling pool a number of residences with lead solder (i.e., solder more than five years old) for sampling sufficiently large to meet the monitoring requirements of this section.

While State approval of monitoring plans would not be required, States would have the authority to disapprove any monitoring plan that does not meet the targeting requirements. A system with a disapproved monitoring plan

would be in violation of the regulations until the State approved a revised plan.

EPA solicits comment on the proposed criteria for selecting the targeted samples.

ii. *Non-Residential Monitoring Alternative.* As described above, EPA is proposing that compliance monitoring be conducted at targeted residences. Based on information from hundreds of water suppliers which have successfully collected standing samples from residences during the last ten years, the Agency expects that virtually all systems will be able to gain access to the required number of residences, especially since many consumers will welcome the information it provides them about the quality of their own drinking water supply. Under the extremely unlikely event that a system is unable to get access to take the required number of samples, EPA may consider allowing an exception to the requirement. Under this rare circumstance, the system would have to demonstrate to the State that it had made several good faith efforts to collect the required samples, including describing to each customer the direct benefits of the sampling. Then the system would have to provide samples from other locations with plumbing characteristics nearly identical to those encountered in targeted residences. For example, a PWS may be able to identify non-residential taps to supplement the accessible residential taps to reach the required number of monitoring sites. These non-residential taps would be required to be connected to plumbing with a configuration and daily water use patterns very similar to those found in single-family residences, to approximate lead levels that would be found in such residences. A second approach might be for a PWS to construct a plumbing system to simulate that found in a home. This simulation would need to be located at the ends of the distribution system, and have either (1) a lead service connection or lead interior plumbing (if there were any lead service connections in the system or its customers' plumbing), or (2) lead solder that is less than five years old. The system would have to assure that the water use patterns in this simulation closely resembled those found in a residence, to ensure the lead levels measured approximate those in private residences.

EPA requests comment on this and any other last-resort sampling approaches which may allow systems to obtain tap samples which represent the water quality found in targeted residences.

b. *Number of Sample Sites.* Two major factors affect the selection of a suitable number of sample sites. First is the degree of certainty that levels and prevalence of lead and copper in water have been identified accurately (more samples result in greater certainty) throughout the community. Second is the cost and ease of implementation of the sampling system (more samples are more costly and a plan requiring more samples may be more difficult to implement). In designing the sampling plan, EPA considered several important design criteria. These include: The number of samples taken per monitoring period (by system size), the length of the monitoring period, the targeted monitoring approach, and the desire to know in advance the maximum total number of samples which would be required from each supplier. Having considered these factors and criteria, EPA has developed a proposal which is relatively low in cost and easy to implement. It clearly defines the number of samples required from each system and it requires the minimum number of samples from small systems.

EPA is also considering an alternative sampling plan and may adopt it in the final rules. Compared to the proposal, this alternative would provide greater certainty about the lead and copper levels and reduce the monitoring costs for large systems, but it may increase monitoring costs for small systems. EPA solicits comment on both the proposed and the alternative sampling plans described below. EPA is interested in how it might improve the proposed approach to increase the certainty it provides regarding lead and copper levels and how it might improve the alternative to make it less costly to implement. In particular, EPA solicits comments on the proposed and alternative approaches to monitoring including the choice of standard levels, appropriate numbers of samples, frequency of sampling, methods for evaluating sample results relative to the no-action levels, and the design of compliance rules within the context of a sampling and evaluation program.

i. *Proposed Approach.* Under the approach proposed by this notice, the number of sample sites would be based on system size. Water suppliers would be required to monitor on this schedule starting by the date specified in Table 16. Under the proposed approach, the system would collect one sample from each sample site (i.e., targeted residence) according to the frequency listed in Table 17 until compliance is established by meeting all no-action levels for at least one year or by completing implementation of a State-approved treatment plan (whichever is later). Thereafter State may reduce the required monitoring frequency for systems serving more than 3,300 persons to a minimum of, one annual sample set taken during July, August, or September from each site. Systems serving 500–3,300 persons would take one sample set during July, August or September and repeat the sampling at least every two years. Systems serving fewer than 500 persons would take one sample set during July, August, or September and repeat the sampling at least five years. Non-transient non-community water systems would not be allowed to reduce their monitoring. Any additional samples taken (beyond those required by the regulation) which a system wants to use to determine whether the no-action levels are met must meet the targeting criteria discussed above.

TABLE 17.—NUMBERS OF SAMPLES AND FREQUENCY OF SAMPLING FOR THE LEAD AND COPPER CORROSION TREATMENT REQUIREMENT UNLESS REDUCED BY THE STATE

Population served	Number of samples
>100,000	50/quarter.
10,001–100,000.	30/quarter.
3,301–10,000	20/quarter.
500–3,300	10/year for 1 year, repeated every 2 years.
<500	10/year in one year, repeated every 5 years.

ii. *Alternative Sampling Plan.* EPA is also considering an alternative to the proposed sampling plan and may adopt it in the final rules. This alternative, although somewhat more complex in design, would require, for many systems, fewer or an equal number of samples than required under the proposed sampling scheme.

The alternative plan is based on a double sampling scheme developed by Dodge and Romig (1959). The plan uses a two-tier approach. A supplier would be required to obtain a relatively small number of samples in the first stage and then, based on the outcome of the initial sampling, would be either relieved of further sampling for that monitoring period or required to obtain additional samples during that monitoring period to determine whether the system was in compliance or needed to take further action. In localities where lead levels at the tap are generally either quite low or quite high, sampling would probably be limited to the first tier.

A benefit of this approach is that no system fails to meet a no-action level (or alternative approved by the State after a system has demonstrated optimization) on the basis of just one exceedance. However, this benefit comes at a cost of increased sampling in some circumstances for the smallest systems.

Table 18 specifies the number of samples to be obtained for systems serving populations of various sizes (leftmost column). The following discussion explains how the alternative sampling plan would be used to determine whether a PWS meets the no-action level for a maximum of 0.020 mg/l lead. After testing the appropriate number of samples in Stage 1, a system would "pass" and be excused from further sampling if no (zero) samples exceeded the lead maximum no-action level. If the number of such exceedances was greater than the specified allowable number (rightmost column), the system would "fail" and also be excused from further sampling, but would be required to take further actions. For example, if the system has not yet installed or improved corrosion control treatment, it would be required to do so. In cases where the number of exceedances in Stage 1 was not greater than the allowable number, systems would be required to collect the number of additional samples indicated for Stage 2. Passing or failing would depend on the total number of exceedances in the combined groups of samples. For example a system serving 100,000 persons that obtained more than a total of three samples with lead levels above the maximum no-action level in 40 samples would fail and having to undertake corrosion control treatment.

Figure 3 illustrates the decision process involved in applying this scheme.

TABLE 18.—NUMBERS OF SAMPLES REQUIRED IN STAGE 1 AND STAGE 2 OF DOUBLE-SAMPLING PLAN [1]

Population size	Number of samples		Allowable exceedances
	Stage 1	Stage 2	
<500	10	5	1
500–3,300	10	10	1
3,301–10,000	20	10	1
10,001–100,000	25	15	2
>100,000	30	20	3

[1] Frequency of sampling would be the same as under the proposed approach. Stage 1 and Stage 2 samples would be taken in the same monitoring period.

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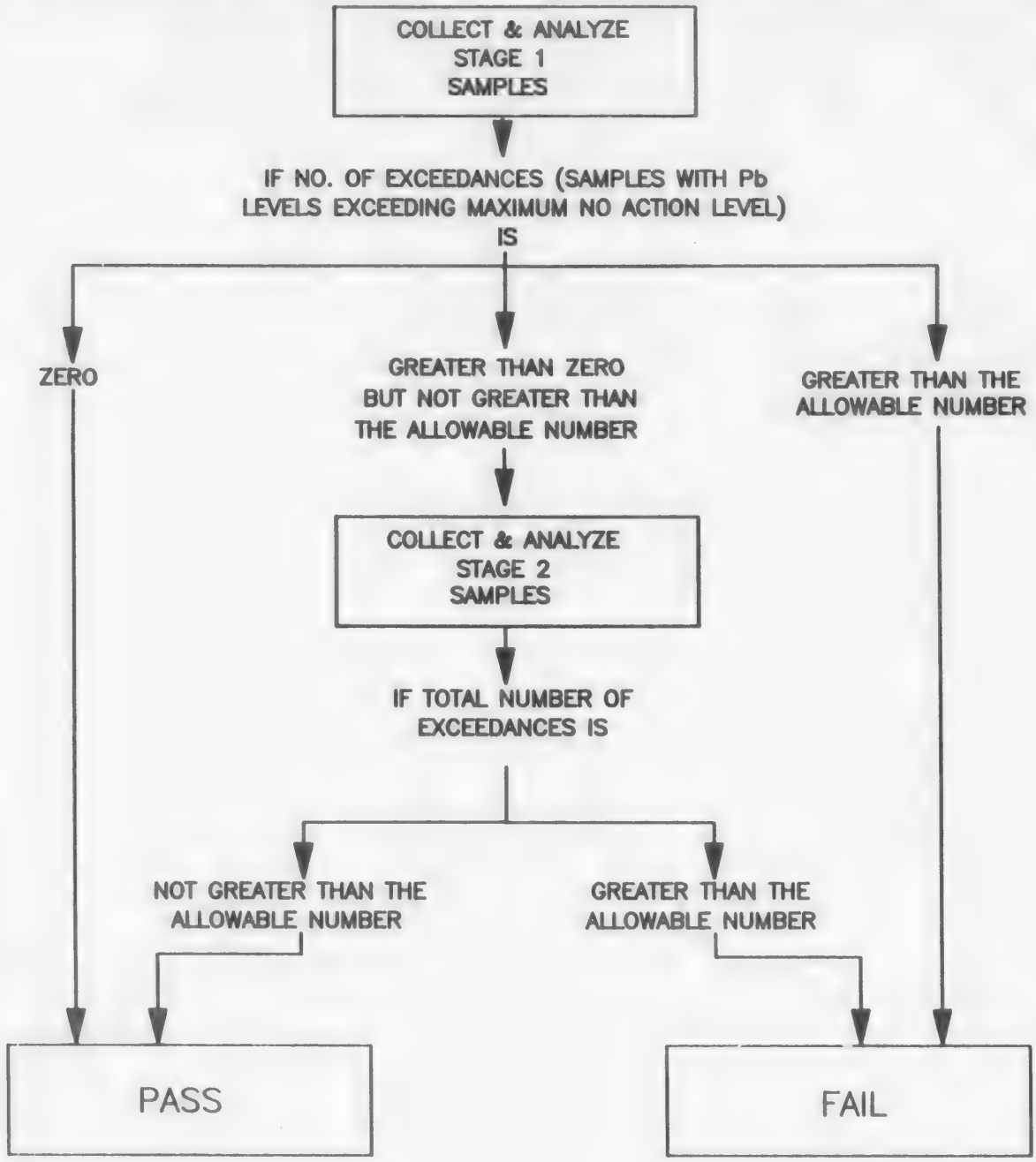

FIGURE 3 DOUBLE SAMPLING DECISION PROCESS.

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If the samples are representative of the taps under consideration, application of this scheme provides 90 percent confidence that not more than 14 percent exceedances would occur among the taps (Svensgaard, 1988).

3. Monitoring Requirements for Non-transient Non-community Water Systems

Non-transient non-community water systems would be required to monitor water entering the distribution system once every five years for compliance with the MCLs for lead and copper. To demonstrate compliance with the treatment technique requirement, NTNC water systems would be required to monitor lead, copper, and pH (in a morning first draw or service connection sample) at least one tap annually during the months of July, August, or September in each building served by the NTNC water system. The monitored tap would be required to be the tap most frequently used for water consumption, such as a kitchen tap.

4. Additional Data Collection

EPA is currently collecting additional data to support this regulation for lead and copper in drinking water, particularly data on lead service line replacement. EPA solicits any additional data on pipe replacement or any other aspect of this proposal from the public.

EPA has developed a monitoring protocol for measuring lead in drinking water and guidance for using it which is more detailed than the protocol required under the proposed regulations. This more detailed protocol is available to the public from EPA. EPA welcomes data from samples taken under this protocol which may help to answer any of the issues highlighted in this proposal.

The monitoring protocol offers a means to determine whether a shorter standing time such as 30 minutes may be successfully substituted for the 8 to 18 hour standing time that would be required for morning first draw samples. In addition, the guidance would assist water suppliers in locating the sources of lead in drinking water (i.e., water mains, service lines, or interior plumbing). This information would assist systems in establishing sampling points for targeted monitoring and for focusing public education programs.

EPA may be able to provide technical assistance to a limited number of water suppliers which are interested in conducting extensive lead monitoring, and are willing to share all data with EPA in exchange for the support. Specifically, EPA is interested in before-and-after treatment data from individual residences served by water suppliers instituting corrosion control treatment and before-and-after data from individual residences in communities replacing PWS-owned or -controlled portions of lead service lines or connections. This information also could be used to assist decisions among the various options described in this proposal, in particular. Data from various tap samples taken before and after treatment would assist the Agency in further assessing the alternative of requiring replacement of lead service lines and connections under the ownership or control of water suppliers. Collection of systematic data of this type also may allow the Agency to better estimate the costs and benefits of the rule.

VI. Public Notification

Under section 1414(c)(1) of the Act, each owner or operator of a public water system must give notice to persons served by it of (1) any violation of an MCL, treatment technique requirement, or testing provision prescribed by an NPDWR; (2) failure to comply with any monitoring requirement under section 1445(a) of the Act; (3) existence of a variance or exemption; and (4) failure to comply with the requirements of a schedule prescribed pursuant to a variance or exemption. The 1986 amendments required that within 15 months of enactment, EPA amend its current public notification regulations to provide for different types and frequencies of notice based on the differences between violations which are intermittent or infrequent and violations which are continuous or frequent, taking into account the seriousness of any potential adverse health effects which may be involved.

EPA promulgated regulations revising the public notification requirements on October 28, 1987 (52 FR 41534). The regulations require that public notices for MCL, treatment technique violations and violations of a variance or exemption ("Tier 1 violations") contain mandatory health effects language specifying concisely and in nontechnical terms what adverse health effects may occur as a result of the violation. States and water utilities remain free to add additional information to each notice, as deemed appropriate for specific situations. Community water systems (CWSs) with Tier 1 violations must notify the public by newspaper or mail or hand delivery. Community water systems which fail to comply with any monitoring or testing requirements, which are granted variances or exemptions, or are required to give newspaper notice repeated quarterly by mail or hand delivery, with additional notice required at State discretion. NTNC systems may either notify in the same manner as CWSs or post a notice continuously.

Violations of the lead or copper MCLs or the treatment technique requirements of this rule would be Tier 1 violations. Violations of the treatment technique requirement include but are not limited to any of the following:

(1) Failure to submit or apply for (depending on system size) a treatment plan by the date required, if required.

(2) Failure to implement any treatment plan requirement by the date specified in the treatment plan, including failure to implement required corrosion control treatment, failure to demonstrate to the State's satisfaction that treatment is optimal, failure to continue required treatment.

(3) Failure to design and implement a public education program, if required.

For Tier 1 violations, EPA is proposing the following mandatory health effects language:

Lead

The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that lead is a health concern at certain exposure levels. Lead is a soft, dull, gray metal that has frequently been used in water supply plumbing materials, especially flux, solder, pipes, and brass and bronze fixtures. Lead usually contaminates drinking water as a result of the corrosion of these plumbing materials by the water they carry. Lead has been shown to cause a variety of adverse health effects in humans and animals. In humans, lead has been shown to interfere with the formation of red blood cells (heme synthesis), cause anemia, cause kidney damage, impair reproductive function, reduce birth weight, cause premature birth, delay physical and mental development in babies and young children, impair mental abilities in children, and increase blood pressure in adults. Many of these effects have been observed at relatively low exposure levels. Studies on animals indicate that lead may also cause cancer at high doses. EPA has set an enforceable drinking water standard at 0.005 ppm (parts per million) for lead leaving the treatment plant and entering the distribution system. EPA also requires public water systems to treat their water to minimize lead contamination resulting from the corrosion of plumbing materials when lead in tap water that has been standing overnight exceeds an average of 0.010 ppm. Drinking water that meets these standards is associated with little of this

risk and should be considered safe to drink.

Copper

The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that copper is a public health concern at certain levels. Copper is an orange metal that is commonly used for plumbing pipes in homes and other buildings. Copper generally contaminates drinking water as a result of the corrosion of copper pipes by the water they carry. When copper corrodes, the water and sink are often stained green. Copper is an essential nutrient, but at high doses it has been shown to cause stomach and intestinal distress, liver and kidney damage, and anemia. Persons with Wilson's disease may be at higher risk from copper toxicity than the general public. EPA has set an enforceable drinking water standard for copper at 1.3 ppm (parts per million) for water leaving the treatment plant and entering the distribution system. EPA also requires public water systems to treat their water to control copper contamination resulting from the corrosion of plumbing materials when copper in tap water that has been standing overnight exceeds 1.3 ppm in more than 5 percent of samples. Drinking water that meets this standard is associated with little to none of this risk and should be considered safe to drink.

VII. Variances and Exemptions

A. Variances from MCLs and Exemptions from the MCLs and Treatment Technique Requirements

Under the Safe Drinking Water Act, variances from MCLs and exemptions from MCLs and treatment technique requirements are permitted only if the granting of the variance or exemption will not result in an unreasonable risk to health (URTH). Sections 1415(a)(1)(A) and 1416(a)(3). States with primacy have authority to grant variances and exemptions.

Variances from MCLs may be granted to water suppliers that have applied BAT but which fail to meet the MCL using that technology. Section 1415(a)(1)(A). Variances from MCLs are generally designed to address cases in which the source water is so contaminated that even application of BAT is insufficient to effectively reduce contaminant levels to below the MCL. Water suppliers that obtain variances from MCLs must be placed on a schedule to come into compliance with the MCL "as expeditiously as practicable" and must implement any additional control measures in the interim prescribed by the State.

Exemptions from both MCLs and treatment technique requirements may be granted to water suppliers due to compelling factors (including economic factors). Section 1416(a). Systems granted an exemption receive additional time to install BAT or the required treatment technique. The exemption may be extended for up to 3 years if the system makes certain showings. Section 1416(b)(2) (A) and (B). Systems which serve fewer than 500 persons may obtain extendable two-year extensions under certain conditions. Section 1416(b)(2) (C). As with variances, exemptions must include a schedule for compliance and requirements for implementing any necessary interim control measures.

EPA is not now proposing to designate by rule a specific level of lead or copper in drinking water that constitutes an unreasonable risk to health. To date, the Agency has not established in regulations URTH levels for any contaminant. However, as for other contaminants, EPA intends to publish guidance regarding what drinking water contaminant levels would constitute an unreasonable risk to health for States to use in deciding whether to grant variances or exemptions to public water systems. This guidance will be available for public review and comment and will be completed by the time the final regulation for lead in drinking water becomes effective.

B. Variances From the Treatment Technique Requirements

The Act also allows variances from treatment technique requirements, but these are fundamentally different from variances from MCLs. Variances from treatment technique requirements are granted to water suppliers that do not need to implement the treatment because they have high quality source water, so treatment is unnecessary to protect the health of persons served by the water supply. Section 1415(a)(1)(B).

Because of the design of the treatment technique requirement for corrosivity proposed in this rule, EPA believes that the need for variances from the proposal treatment technique requirement would be rare. Specifically, since the proposed rule requires systems to optimize corrosion control, i.e., lower lead levels as much as technically feasible with corrosion control treatment, by definition, all public water systems could comply with the treatment technique requirements.

The only case in which application of corrosion control treatment would not be necessary or beneficial in reducing lead levels is the rare community that has no lead or copper materials in its plumbing and distribution system, including private residential plumbing. Such communities may include new trailer home parks or other developments of prefabricated housing which were constructed using all plastic piping. If a water supplier could demonstrate that no plumbing materials containing lead have been used in the construction of any homes in the community or in any distribution facilities, a variance from the treatment technique requirement could be granted.

EPA solicits comment on granting of variances from the treatment technique requirements, especially whether there are other conditions under which the treatment technique may not be necessary or beneficial for reducing lead and copper exposures via drinking water.

C. Point-of-Use (POU) and Point-of-Entry (POE) Devices and Bottled Water

EPA believes that central treatment should be the primary means of attaining MCLs and providing water equivalent to water treated as set out in an NPDWR prescribing a treatment technique, such as the corrosion control technique set out in this proposal. However, although the long-term goal for these systems is to comply with NPDWRs with centrally treated and distributed water, under this proposal EPA would allow the State to require the use of POU devices or bottled water to avoid an unreasonable risk to health, as a condition of receiving a variance or an exemption. This may be especially appropriate in the case of exemptions for small systems, i.e., systems with less than 500 connections, because their exemptions may be extended for one or more two-year periods. The goal of application of non-central treatment or bottled water is to provide water of equivalent quality to that which would be provided by a traditional well-operated central treatment facility.

In prescribing the use of POU devices, the State would be required to impose the conditions outlined below. If a PWS distributes bottled water as a control measure, the PWS must ensure that one of the following conditions is met:

(1) The bottled water must be subject to a monitoring program that provides adequate assurances that the water meets all MCLs. The public water system must monitor the bottled water for lead and copper and all other MCLs in the first quarter that it supplies water to the public, and annually thereafter. Results of the monitoring program would be provided to the State annually; or

(2) The public water system must receive a certification from the bottled water company that (a) the bottled water supplied has been taken from an "approved source" as defined in 21 CFR 129.3(a); (b) the bottled water company has conducted monitoring in accordance with 21 CFR 129.80(g)(1)–(3); and (c) the bottled water does not exceed the MCLs or quality limits set out in 21 CFR 103.35. The public water system would be fully responsible for the provision of sufficient quantities of bottled water to every person supplied by the public water system including delivery via a door-to-door bottled water delivery system.

These conditions constitute the minimum standards for protection of public health.

Point-of-entry devices for removal of lead or copper from drinking water would not be allowed to achieve compliance with this proposed rule because they do not prevent lead or copper from entering the water after it leaves the device. Many such devices provide reverse osmosis (RO) or ion exchange treatment, and can actually make water more corrosive, potentially resulting in higher lead levels at the tap.

VIII. State Implementation

The primary implementation agencies for drinking water regulations are the States. Fifty-four out of 57 jursidictions have applied for and received primary enforcement responsibility for the public water supply supervision program (primacy). To implement the federal regulations for drinking water contaminants, States must adopt their own regulations which are at least as stringent as the federal regulations. This section of today's proposal describes the provisions the States would be required to adopt to implement this proposed rule.

One of the deficiencies in the existing program implementation regulations in 40 CFR Part 142 which EPA plans to correct in an NPRM later this year is that the regulations do not require States with primacy to revise their programs following EPA promulgation of new or revised NPDWRs or to adopt the new or revised requirements, nor do they specify a procedure for doing so. EPA intends to propose amendments which would require States to revise their programs following the promulgation of new or revised NPDWRs to maintain primary enforcement responsibility. Under the SDWA, EPA has had a strong and continuing policy of approving only those State programs that adopted the full EPA program, e.g., all NPDWRs; States cannot obtain partial or conditional primacy. EPA intends to continue this "full primacy" policy as it implements the 1986 SDWA amendments. (Partial primacy would be confusing; the State would be implementing part of the program and EPA the other, and it would be unclear which provisions of Federal and state law applied to a given public water system.)

As part of the amendments to the primacy regulations, EPA is planning to propose procedures for revising State programs that are similar to those in Part 142 for obtaining initial primacy. The amendments would require States to meet the basic requirements for obtaining primary enforcement responsibility (see 40 CFR 142.10) for each new or revised NPDWR and any primacy requirements specific to the new or revised NPDWR which EPA has established. It is anticipated that such regulation-specific requirements would be necessary only in those situations where the NPDWR provides flexibility to the State on how to accomplish a particular requirement. If these regulation-specific requirements are needed, EPA will promulgate them at the same time it promulgates the NPDWR. Today's proposal includes regulation-specific requirements that a State would be required to include in a program revision to adopt the proposed lead and copper NPDWRs. EPA solicits comments only on these specific requirements. Comments on the broader changes to the primacy requirements in Part 142 will be solicited when those changes are proposed. Today EPA is also proposing the changes to the reporting and recordkeeping requirements needed to implement the lead and copper NPDWRs. EPA also solicits comments on these requirements. EPA's proposed changes to Part 142 are explained below.

A. Special Primacy Requirements for States To Adopt 40 CFR Part 142, Subpart I—Control of Lead and Copper

The regulations proposed at 40 CFR Part 141, Subpart I, Control of Lead and Copper, provide the State discretion with regard to how the objectives of the rule are achieved. For instance, the State must approve a system's demonstration that it has minimized the corrosivity of its water and must approve the system's final operating parameters. In these cases and other instances where the State has discretion, State regulations would be required to augment the general national regulations to establish enforceable requirements and to inform each public water system to what specific requirements it is subject.

To ensure that the State program includes all the elements necessary for an effective, enforceable program, this notice proposes that to obtain approval of a program revision to adopt the NPDWRs for lead and copper, the State's request for approval would be required to include the following:

(1) The procedure or criteria the State will use for determining the frequency with which a system must monitor, including the monitoring frequency after a system has exceeded the lead or copper MCL. The State must include a procedure for notifying the system of the new monitoring requirements with which it must comply and for enforcing these requirements.

(2) The requirement for a materials evaluation to identify monitoring locations, specifying the elements which must be included in the evaluation. Further, the State must specify how a system can demonstrate to the State that sufficient residences with the required characteristics for monitoring are not available.

(3) The procedures/criteria the State will use to evaluate treatment plans submitted by systems serving more than 3,300 persons, to develop treatment plans for systems serving fewer than 3,300 persons, to approve treatment plans, and to evaluate treatment and public education performed by systems under the treatment plans, in accordance with proposed § 141.85. The State must also specify (a) the criteria it will use to determine that corrosivity has been minimized if the system is still not meeting the no-action levels after installing or improving treatment, and (b) a method of informing the system of its new approved operating parameters.

(4) The criteria the State will use to evaluate data submitted by a system on the effectiveness of its public education program and to determine whether the system must modify subsequent public education efforts.

(5) Procedures the State will use to provide systems serving 3,300 or fewer persons with treatment plans.

B. State Reporting and Recordkeeping Requirements

In this notice, EPA is proposing changes to the existing reporting and recordkeeping requirements to implement the proposed lead and copper NPDWRs. These changes would require States to keep records of:

(1) Any system which has been allowed to reduce the frequency at which it monitors for compliance with (a) the lead and copper MCLs and/or (b) the no-action levels which trigger the

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treatment technique requirements, or other approved operating parameters.

(2) Any system which is required to perform increased monitoring and the frequency of that monitoring.

(3) Approvals of treatment plans as specified in proposed § 141.84.

(4) All determinations that systems that have finished implementing treatment plans have begun meeting the no-action levels or have minimized the corrosivity of their water.

(5) All evaluations of public education programs and of all determinations that systems are required to modify subsequent public education programs.

This proposal would also amend the State reporting requirements to implement the lead and copper NPDWRs. States would be required to provide EPA quarterly a list of systems which:

(a) May reduce their monitoring frequency in accordance with proposed § 141.86 (c) and/or (d)(4).

(b) Are required to increase their monitoring frequency in accord with § 141.86(c)(4).

(c) Have received State approval for their treatment plan, or for systems serving 3,300 or fewer persons that have received a treatment plan from the State.

(d) Have successfully demonstrated that optimal corrosion control has been installed. This report should indicate whether the system is now meeting the no-action levels or operating under other parameters approved by the State. In the latter case, the report should specify the new parameters.

States would also be required to report any evaluations of public education programs and any determinations that a system must modify subsequent public education programs. Under the existing regulations, States must provide EPA a summary of violations of primary drinking water regulations; therefore; no additional requirement for reporting violations to EPA is specified in this proposal.

EPA solicits comments on all the proposed changes, including recordkeeping, reporting, and the special primacy requirements, to Part 142 to implement the NPDWRs for lead and copper also proposed today. Comments should specifically address the appropriateness of these requirements, the effect of these new requirements on State programs, and the ability of the State to implement the requirements of the rule.

C. System Reporting and Recordkeeping Requirements

In order to facilitate implementation and enforcement of the regulations proposed today, water systems would be required to maintain records of and report to the state information relating to the proposed regulation.

Systems that serve more than 500 persons would be required to report to the State the results of all monitoring required by this subpart within 10 days of the end of each calendar quarter the system is in operation for any period of time. Systems that serve 500 or fewer persons would be required to report such results to the State within 10 days of the end of each calendar year such system is in operation for any period of time. All systems would be required to certify that the information submitted is accurate. To the extent systems perform more monitoring than required by the proposed regulations, the systems would be required to include the results of the additional monitoring in their reports to the State. Systems would be required to include the identification and location of sampling sites monitored in their reports of monitoring data.

Systems operating under an approved treatment plan would be required to, according to a schedule established by the State, report to the State the system's progress in completing the treatment plan's interim steps. All systems applying corrosion control treatment, would be required to report any changes in treatment, including changes to treatment for purposes other than corrosion control and cessation of treatment due to mechanical or operating failures, within 14 days of the change in treatment.

Systems operating under an approved treatment plan containing a public education program would be required to report the system's progress in completing the public education program requirements in the reports submitted to the State. If the public education program is being targeted to particular segments of the consumer population, a description of how this targeting is consistent with the proposed regulations would be required to provide data to the State that indicate that, as a result of the public education program, the users' knowledge about lead in drinking water enables them to alter voluntary their water use patterns to reduce consumption of lead-contaminated water.

The proposed regulations would also establish a general reporting authority, which would allow the Administrator to require a system to establish and maintain such records, reports, or information as the Administrator deems necessary to determine whether the system has acted or is acting in compliance with the proposed regulations.

IX. Review by the Science Advisory Board

As required by the SDWA, EPA's Science Advisory Board (SAB) was offered the opportunity to review this proposal. They met on June 2 and 3 1988 in Cincinnati, Ohio. The SAB's comments will be considered and factored into the final rule together with the comments from the public received during the comment period.

X. Impact of this Regulation

A. Regulatory Impact Analysis

Under Executive Order 12291, this action is a major regulatory action, because it will have a major financial or economic impact on the country. As required by the Executive Order, EPA conducted a Regulatory Impact Analysis (RIA) that is available for review as part of the docket for this rulemaking (EPA 1988a). This regulation has been reviewed by the Office of Management and Budget as required by Executive Order 12291.

Costs

EPA analyzed the economic impact of this regulation in two separate parts; The impact attributable to the control of lead and copper in source water (the "MCL impacts," in Table 19) and the impact attributed to the corrosion control requirements (also shown in Table 19).

TABLE 19.—SUMMARY COST IMPACTS OF PROPOSED LEAD AND COPPER REQUIREMENTS [1]

	Lead (5 ug/l)		Copper (1,300 ug/l)		Total [2]
MCL Impacts					
Systems Affected	880		[illegible]		950
National Cost of Treatment ($M):					
Capital	320		35		350
O&M (Annual)	30		3		30
Annualized [3]	55		[illegible]		60
Annual Cost per Family ($/yr) by System size (people served):					
Very Small (25–500)		340		380	
Small (501–3,300)		91		130	
Medium (3,301–50,000)		28		70	
Large (Over 50,000)		[illegible]		[illegible]	
Treatment Technique Requirement Impacts					
Systems Affected		53,000 [4]			
National Cost of Treatment ($M)					
Capital		630			
O&M (Annual)		160			
Annualized		210			
Optimization Demonstrations (Annual in $M)		[illegible]			
Public Education (Annual in $M)		12			
Annual Cost per Family ($/yr) by System size (people served):					
Very Small (25–500)		27.0			
Small (501–3,300)		4.6			
Medium (3,301–50,000)		2.5			
Large (Over 50,000)		0.7			
Total Cost of Rule ($M)	MCL		Corrosion control		Total
Capital	350		[illegible]		980
O&M (Annual)	37		160		200
Annualized	[illegible]		220		[5] 280

[1] Costs are expressed in 1988 Dollars. Totals may not tally due to independent rounding.
[2] Assuming no co-occurrence of lead and copper.
[3] Annual cost of capital 3% over 20 years plus 1 year of O&M.
[4] Includes double counting of some systems which will have to treat for source water contamination as well as for concentrations at the tap exceeding the no-action level. 42,978 systems are estimated to install treatment, and conduct public education programs and optimization demonstrations only.
[5] Includes annualized capital, O&M, optimization demonstration, and public education costs, but excludes state implementation costs of $16 m per year.

It is estimated that about 880 systems would exceed the proposed MCL for lead at the entry point to the distribution system and thus need to treat their source water. About 66 systems would exceed the proposed MCL for copper at the entry point to the distribution systems and thus need to treat their source water. On an annualized basis, the compliance costs for the lead and copper MCLs would be about $60 million.

There are cost impacts associated with the treatment technique (corrosion control and public education) requirements as well. These impacts have been broken into three tiers, reflecting the stepped nature of the proposal and its alternatives. Systems would incur treatment costs when they fail to meet the no-action levels. Approximately 53,000, or 66 percent of all systems would be expected to incur costs under the proposed treatment technique requirements. On an annualized basis, corrosion control treatment optimization demonstration and public education would result in costs of about $221 million.

Monitoring costs would be incurred by all of the approximately 79,000 community and non-transient, non-community systems. EPA estimates that the national annualized cost of monitoring for this proposal would be about $12 million per year (Table 20).

Table. 20.—Monitoring Costs of the Proposed Lead and Copper Requirements*

Systems Affected	79,000
National Cost ($M1988)	
Annual Monitoring	12
Cost per Family by System Size ($1988/year/Household)	
Very Small (25–500)	$0.88
Small (501–3,300)	0.30
Medium (3,301–50,000)	0.19
Large (over 50,000)	0.02
Total Annual Cost of Monitoring ($M1988)	
Very Small (25–500)	$1.60
Small (301–3,300)	2.20
Medium (3,301–50,000)	6.90
Large (over 50,000)	1.40

* Rounded to two significant digits.

The entire proposal, including both the MCL and treatment technique requirements for lead and copper, would require about 54,000 systems to add $980 million in capital equipment, and incur $200 million per year to operate and maintain it. Monitoring costs are expected to be $12 million per year. State implementation costs are estimated to increase by approximately $16 million. On an annualized basis, the cost of the rule is expected to be nearly $280 million for capital, operation and maintenance, monitoring, and State implementation.

The uncertainty in the costs, particularly for small systems, has not been fully evaluated. Based on comments and further analysis, an addendum to the draft Regulatory Impact Analysis to be completed when this rule is promulgated will evaluate these uncertainties.

Benefits

The systems that incur the costs of complying with the proposed rule are likely to be the same systems that experience the health and materials benefits. The materials benefits of this regulation may be as high as $500 million per year. These benefits would pay for the entire cost of this rule if considered on a national basis.

The Agency evaluated the expected health benefits of the proposed rule. The Agency estimated the number of children who would be expected to experience decreased blood lead levels as a result of reduced water lead levels. In particular, EPA examined the effects of changing the water lead distribution experienced by people served by systems which are expected to install or improve corrosion control treatment

after missing the no-action levels. In the first step of the analysis, EPA estimated the proportion of children expected to have their blood lead levels reduced to below 10, 15, or 25 ug/dl as a result of reductions in water lead levels (Marcus and Holtzman, 1988). EPA estimates that about 138 million people are served by PWSs that would be expected to install corrosion control treatment (EPA 1988a). Of these, about 8.8 million are children aged 6 months to 5 years. Therefore, EPA estimates that 264,000 to 704,000 children in this age group would have blood lead levels reduced to below 10 ug/dl, 88,000 to 176,000 children would have their blood lead levels reduced to below 15 ug/dl, and 3,500 to 5,300 would have blood lead levels reduced to below 25 ug/dl. The estimates are presented in a range to reflect the uncertainty regarding the water lead levels that would result from compliance with the proposal.

Other groups of the exposed public would also be expected to experience benefits from the proposed rule, including fetuses, infants, older children, and adults. The particular types of health effects that would be avoided by these persons are discussed in *Reducing Lead in Drinking Water: A Benefits Analysis* (EPA, 1986a). However, the Agency has not calculated the proportion or number of persons in each of these categories who would be brought below specified blood lead levels.

Figure 4 summarizes the health effects associated with various blood lead levels of concern. These include reduced IQ and stature decrements in children, premature birth, low birthweight, slowed mental and physical development in fetuses and infants, and hypertension in adult men.

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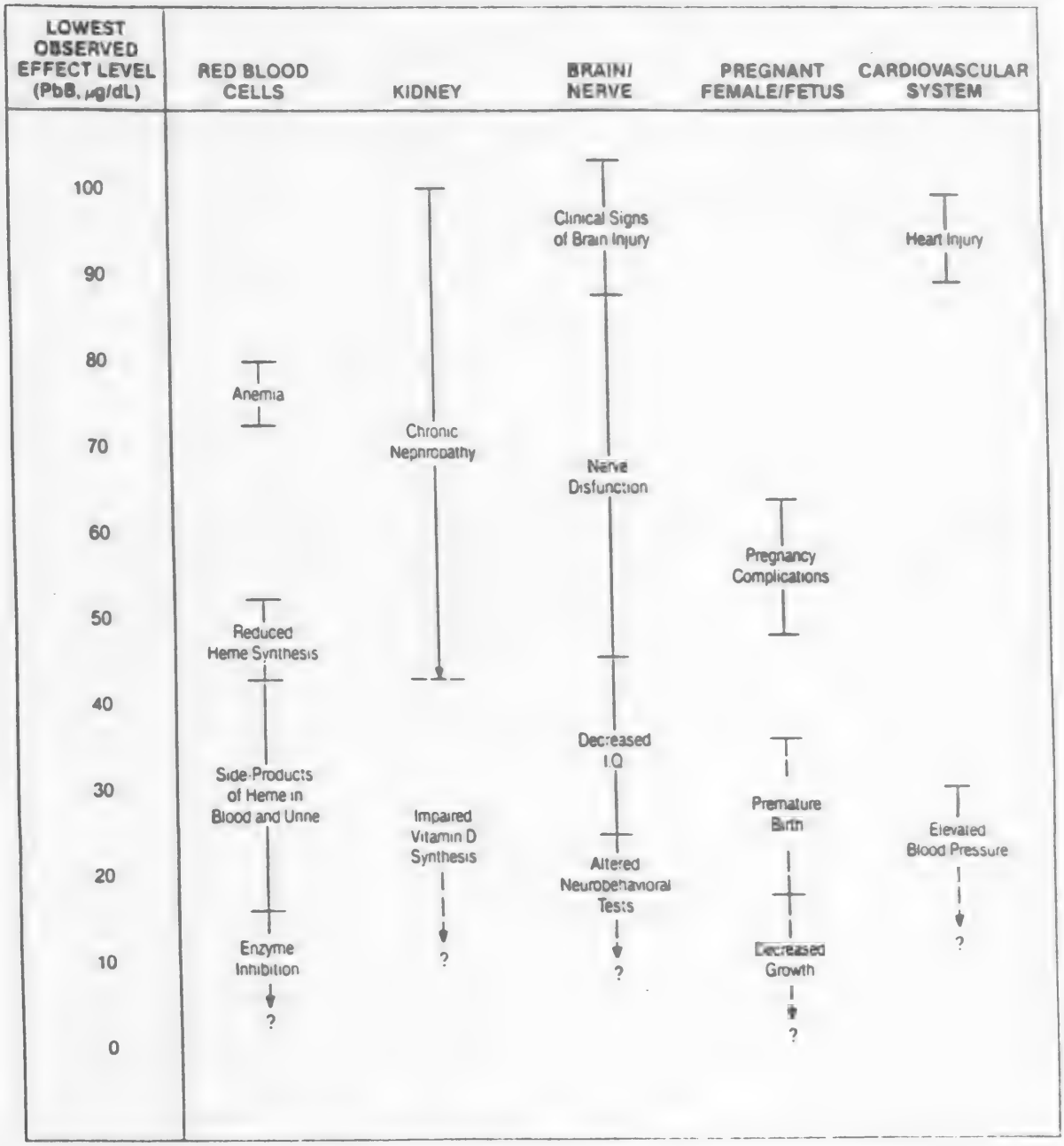
Figure 4

ADVERSE HEALTH EFFECTS OF LEAD



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The Agency also considered the relative benefits of the proposed approach compared to those which might be expected to occur if one or more of the alternatives discussed above were adopted. In each case, the actual outcome of adopting an alternative approach is uncertain. Therefore, Table 21 presents a qualitative comparison of the proposal with the alternatives. Costs, benefits, administrative complexity, and enforceability are considered. Expected net benefits are listed as the same as the proposal, less than the proposal, or greater than the proposal. For example, difficult problems of implementation could limit the reductions in water lead levels that might otherwise be expected from adoption of an alternative.

TABLE 21.—COMPARISON OF ALTERNATIVES TO THE PROPOSAL

Alternative	I			II		3	4	5
	Annual Costs			Theoretical Annual Benefits		Administrative Complexity	Enforce-ability	Expected Benefit [1]
	MCL	Corr. Ctrl	Monitrg	Reduced Mat Damages	Health			
1. National requirement for Pb service replacement.	same	inc	inc	same	inc	inc	dec	?
2. Require opt corrosion control for *additional* no-action level of 20 ug/l as maximum.[2].	same	inc	same	inc	inc	inc	same	same (?)
3. Require opt corrosion control for *additional* no-action level of 30 mg/l alkalinity.	same	inc	same	inc	inc	small increase	same	same (?)
4. Raise max to 30 ug/l to trigger trtmt	same	small increase	same	? inc ?	small increase	small increase	same	same (?)
5. Max of 20 to *replace* other no-action levels to trigger trtmt.	same	inc	dec	inc	inc	inc	inc	?
6. MCL at the tap, MCL=30 maximum	dec	dec	same	dec	dec	dec	inc	dec
7. Two-tiered sampling	same	same	inc	same	same	inc	same	same
8. Elim pH requirement, guidance assume or as Pb avg of 10 only no-action level to trigger trtmt.	same	dec	dec	dec	dec	dec	dec	same (?)

[1] Considers net effect of factors in columns 1 through 4.
[2] "Maximum" means measured as the 95th percentile of targeted samples, unless the two-tiered sampling alternative (#6) is chosen.

B. Regulatory Flexibility Analysis

The Regulatory Flexibility Act requires EPA to explicitly consider the effect of regulations on small entities. If there is a significant effect on a substantial number of small systems, the Agency must seek to minimize the effects. With respect to the requirements of the Regulatory Flexibility Act, 5 U.S.C. 602 *et seq.*, today's action will not have a significant effect on a substantial number of small entities.

Using the Small Business Administration's definition, a small water utility is one that serves fewer than 50,000 people. There are about 78,000 such systems. Of these, approximately 53,000, or 68 percent, are likely to have contamination levels greater than the MCLs or no-action levels specified in this proposal, and thus would be required to treat their water; this represents a substantial number of systems. The approximate cost of producing water by all systems serving fewer than 50,000 people is $9 billion per year, and the maximum annualized cost of the proposal would be about $281 million, including monitoring. This amounts to 3.1 percent of water production costs for small systems. EPA believes that an increase of this magnitude does not represent a signficant economic impact. Therefore, although the rule will affect a substantial number of small systems, the average effect on small systems as defined by the Small Business Administration would not be significant.

Nevertheless, EPA recognizes that, due to their inability to benefit from economies of scale, the cost impact of regulations tends to increase as the size of a system decreases. In order to prevent these regulations from placing an onerous burden on smaller systems, EPA has included numerous provisions in the proposal which would enhance their ability to comply. Among these provisions are:

1. The monitoring requirements of the rule are phased in over an extra two to three years for small systems.

2. Fewer samples are required for compliance with both the maximum contaminant level and treatment technique parts of the rule.

3. Small systems are required to monitor less often than large systems. Instead of monitoring quarterly, systems serving less than 50,000 people may monitor annually or once every five years.

4. States may take system size into account when determining appropriate elements of the treatment plan, including corrosion control and public education requirements for a given system.

The Agency encourages States to provide technical assistance to small systems which need to install or improve corrosion control. The assistance could include tailoring the treatment plans they provide to small systems to the circumstances of individual public water systems. Further, under the Safe Drinking Water Act, exemptions are available for systems serving fewer than 500 persons if they cannot afford to install best available technology to meet the requirements of an MCL or treatment technique requirement technology, provided there is no unreasonable risk to health. These exemptions may be extended as necessary.

C. Paperwork Reduction Act

The information collection requirements in this proposed rule have been submitted for approval to the Office of Management and Budget (OMB) under the *Paperwork Reduction Act*, 44 U.S.C. 3501 *et seq.* An Information Collection request has been prepared by EPA (ICR No 0270.12) and a copy may be obtained from Eric Strassler, Information Policy Branch; EPA 401 M Street, SW. (PM–223); Washington, DC 20460 or by calling (202) 382–2709.

Public reporting burden for this collection of information is estimated to vary from an average of 1 to 1.4 hours per response, including time for reviewing instructions, searching existing data sources, gathering and

maintaining the data needed, and completing and reviewing the collection of information.

Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Chief, Information Policy Branch, PM–223, U.S. Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503, marked "Attention: Desk Officer for EPA." The final rule will respond to any OMB or public comments on the information collection requirements contained in this proposal.

XI. Request for Public Comment

Throughout this proposal, EPA has requested public comment on many issues and approaches related to this regulation. Many of the major issues for comment are repeated here for the convenience of those who wish to comment on this proposed rule.

1. Should EPA control corrosion by-products with MCLs or a treatment technique?

2. Is an MCL measured at the tap to control both lead from source water and as a by-product of corrosion appropriate? What would be the basis for selecting the level? What monitoring requirements should apply? Should systems that have installed BAT and still cannot meet the MCL at the tap because of private plumbing be considered permanently out of compliance?

3. Should EPA establish national requirements for lead service line replacement?

4. EPA solicits data on contributions of lead service lines and other lead connections to lead levels at the tap, and on lead levels after corrosion control treatment is in place.

5. EPA solicits data on the effect of partial and full lead service line replacement programs on lead levels at the tap.

6. Should EPA reduce to 500 ml the sample size for determining whether a system meets the no-action levels and/or the source water MCLs for distributed water?

7. Should EPA adopt one or more of the following alternatives to this proposal: Treating the fourth no-action level, a maximum of 0.020 mg/l of lead measured as the 95th percentile of targeted samples, the same as the first four no-action levels; adding total alkalinity of 30 mg/l as an additional no-action level to trigger treatment; requiring a system to replace lead service lines and connections that are found to contribute significantly to lead in tap water even after installation of optional corrosion control; a two-tiered approach to monitoring which may increase the efficiency of sampling, so fewer samples might be required of most public water systems; and eliminating pH as a no-action level?

8. Should the MCLs for lead and copper apply at the entry points to the distribution system or to fully flushed water at the consumer tap?

9. Should EPA require water suppliers to adjust corrosion control treatment to account for any blending of water from different sources? How? Please provide any data to support any alternative approaches.

10. Should EPA raise the maximum no-action level for lead to 0.030 mg/l (if it is adopted as a no-action level that triggers treatment) to assure that this alternative could be feasibly implemented; and/or substitute the no-action level of 0.020 mg/l for lead for the average of 0.010 mg/l for lead and pH and alkalinity measures?

11. What information should be included in the public education program?

12. Would the proposed public education program and/or any other similar actions reduce exposure to potentially excessive levels of lead in drinking water?

13. Are the proposed analytical techniques technically adequate and economically feasible?

14. Are the PQL acceptance limits for copper and lead appropriate?

15. Are the proposed criteria for selecting the targeted samples appropriate?

16. EPA requests additional data on samples in accordance with EPA's lead monitoring protocol. EPA is especially interested in corrosion control treatment data which compares lead levels in morning first draw samples before treatment and levels after treatment.

17. What specific level of lead or copper in drinking water constitutes an unreasonable risk to health?

18. Should EPA allow variances and exemptions from the proposed rule? Are there other conditions (in addition to those described) under which the treatment technique may not be necessary or beneficial for reducing lead exposures via drinking water?

19. Are the requirements that a State would be required to include in a program revision to adopt the lead and copper NPDWRs proposed in this regulation appropriate?

21. What will be the effects of the proposed requirements on State programs?

XII. References

The following references are referred to in this notice and are included in the public docket together with other correspondence and information. The public docket is available as described at the beginning of this notice. All public comments received on this proposal are included in the public docket.

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List of Subjects in 40 CFR Parts 141 and 142

Chemicals, Reporting and recordkeeping requirements, Water supply, Administrative practice and procedure, Incorporation by reference.

Dated: August 9, 1988.

Lee M. Thomas,

Administrator.

For the reasons set forth in the preamble, Title 40 of the Code of Federal Regulations is proposed to be amended as follows:

PART 141—NATIONAL PRIMARY DRINKING WATER REGULATIONS

1. The authority for Part 141 continues to read as follows:

Authority: 42 U.S.C. 300g–1, 300g–3, 300g–6, 300j–4, and 300j–9.

2. Section 141.2 is amended by removing the paragraph designations and placing the definitions in alphabetical order, by revising the definitions of "maximum contaminant level," and adding the following new definitions in alphabetical order to read as follows:

§ 141.2 Definitions.

* * * * *

"Corrosion inhibitor" means a substance, such as zinc orthophosphate, capable of reducing the corrosivity of water toward plumbing materials, for example, by forming a protective film on the interior surface of the plumbing materials.

* * * * *

"Distributed water" means water entering the water distribution system after any treatment that may be applied.

* * * * *

"Ends of the distribution system" means areas of the distribution system with low or no water flow in water mains.

* * * * *

"Maximum contaminant level" means the maximum permissible level of a contaminant in water that is delivered to any user of a public water system.

* * * * *

"Morning first draw sample" means a sample of tap water that has been standing in plumbing pipes for 8 to 18 hours and is collected without flushing.

* * * * *

"Optimal corrosion control treatment" is corrosion control treatment which minimizes lead levels in targeted samples.

* * * * *

"pH" means the condition represented by the negative logarithm of the effective hydrogen-ion concentration or hydrogen-ion activity expressed in gram equivalents per liter. pH is used to express both acidity and basicity on a scale whose values run from 0 to 14 with 7 representing neutrality; numbers less than 7 indicate a more acidic solution, and numbers greater than 7 indicate a more basic solution.

* * * * *

"Residence," for the purpose of Subpart I of this part only, means, in the case of a community water system, a house or other dwelling unit. In the case of a non-transient non-community water system, residence means any building served by the public water system.

* * * * *

"Service connection" means the pipe, gooseneck, pigtail, and any other fitting connecting the water main to the building inlet.

"Service connection sample" means a sampling of water that has been standing for 8–18 hours in the building service connection.

* * * * *

"Targeted sample" is a sample taken in accordance with § 141.86(d).

3. Section 141.32 is amended by reserving paragraphs (e)(10)–(12) and adding paragraphs (e)(13) and (14) to read as follows:

* * * * *

§ 141.32 Public notification.

* * * * *

(e) * * *

(10)–(12)—[Reserved]

(13) *Lead.* The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that lead is a health concern at certain exposure levels. Lead is a soft, dull, gray metal that has frequently been used in water supply plumbing materials, expecially flux, solder, pipes, and brass and bronze fixtures. Lead usually contaminated drinking water as a result of the corrosion of these plumbing materials by the water they carry. Lead has been shown to cause a variety of adverse health effects in humans and animals. In humans, lead has been shown to interfere with the formation of red blood cells (heme synthesis), cause anemia, cause kidney damage, impair reproductive function, reduce birth weight, cause premature birth, delay physical and mental development in babies and young children, impair mental abilities in children, and increase blood pressure in adults. Many of these effects have been observed at relatively low exposure levels. Studies on animals indicated that lead may also cause cancer at high doses. EPA has set an enforceable drinking water standard at 0.005 ppm (parts per million) for lead leaving the treatment plant and entering the distribution system. EPA also requires public water systems to treat their water to minimize lead contamination resulting from corrosion of plumbing materials when lead in tap water that has been standing overnight exceeds an average of 0.010 ppm. Drinking water that meets these standards is associated with little of this risk and should be considered safe to drink.

(14) *Copper.* The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that copper is a health concern at certain exposure levels. Copper is an orange metal that is commonly used for plumbing pipes in homes and other buildings. Copper generally contaminates drinking water as a result of the corrosion of copper pipes by the water they carry. When copper corrodes, the water and sink are often stained green. Copper is an essential nutrient, but at higher doses it has been shown to cause stomach and intestinal distress, liver and kidney damage and anemia. Persons with Wilson's disease may be at higher risk from copper toxicity than the general public. EPA has set an enforceable drinking water standard for copper at 1.3 ppm (parts per million) for water leaving the treatment plant and entering the distribution system. EPA also requires public water systems to treat their water to control copper contamination resulting from the corrosion of plumbing materials when copper in tap water that has been standing overnight exceeds 1.3 ppm in more than 5 percent of samples. Drinking water that meets this standard is associated with little to none of this risk and should be considered safe to drink.

4. A new Subpart I is added to read as follows:

Subpart I—Control of Lead and Copper

Sec.

141.80 Applicability.
141.81 MCLGs for lead and copper.
141.82 MCLs and BAT for lead and copper.
141.83 Treatment technique requirement.
141.84 Treatment plan.
141.85 Public education program.
141.86 Analytic and monitoring requirements for lead and copper MCLs and treatment technique requirements.
141.87 Reporting and recordkeeping.

Subpart I—Control of Lead and Copper

§ 141.80 Applicability.

Unless otherwise indicated, each of the provisions of this subpart applies to community water systems and non-transient non-community water systems (hereinafter referred to as "systems").

§ 141.81 MCLGs for lead and copper.

The maximum contaminant level goals (MCLGs) for lead and copper are as follows:

Contaminant	MCLG in mg/l
(1) Lead	Zero.
(2) Copper	1.3

§ 141.82 MCLs and BAT for lead and copper.

(a) The following MCLs for lead and copper apply to water entering the distribution system, after any treatment:

Contaminant	MCL in mg/l
(1) Lead	0.005
(2) Copper	1.3

(b) The Administrator, pursuant to section 1412(b)(6) of the Act, hereby identifies the following as the best technology, treatment technique, or other means available (BAT) for achieving compliance with or issuing variances from the MCLs for lead and copper:

Contaminant	BAT
(1) Lead	(1), (2), (3), (4)
(2) Copper	(1), (2), (3), (4)

Key to BATs in Table.
[1] = Coagulation/Filtration.
[2] = Ion Exchange.
[3] = Lime softening.
[4] = Reverse Osmosis.

§ 141.83 Treatment technique requirement.

(a) This rule establishes a treatment technique requirement to control lead and copper as corrosion byproducts. The treatment technique requirement consists of optimal corrosion control treatment (to minimize lead in drinking water) and public education (to reduce exposure to lead in drinking water). A system that meets the no-action levels specified in paragraphs (b)(1)(i)-(iv) of this section is deemed in compliance with the treatment technique requirement of this paragraph.

(b) The specific steps a system must take to comply with the treatment technique requirement of paragraph (a) of this section depend on the lead level, copper level, and pH measured as specified in § 141.86 (a) and (d) of this part. These steps are set out below:

(1) The no-action levels are as follows:

(i) The arithmetic average lead level of the required samples is less than or equal to 0.010 mg/l;

(ii) The lead level in at least 95 percent of the required samples is less than or equal to 0.020 mg/l;

(iii) The copper level in at least 95 percent of the required samples is less than or equal to 1.3 mg/l;

(iv) The pH is greater than or equal to 8.0 in at least 95 percent of the required samples.

(2) If a system cannot meet one or more of the no-action levels specified in paragraph (b)(1) of this section, it must obtain and implement a State-approved treatment plan, as specified below:

(i) If the arithmetic average lead level in the required samples exceeds 0.010 mg/l, the State-approved treatment plan must require the system to install optimal corrosion control treatment, as specified in § 141.84 of this part, and to conduct a public education program, as specified in § 141.85 of this part.

(ii) If the lead level exceeds 0.020 mg/l in more than five percent of the required samples, the State-approved treatment plan must require the system to conduct a public education program, as specified in § 141.85 of this part.

(iii) If the lead level exceeds 1.3 mg/l in more than five percent of the required samples, the State-approved treatment plan must require the system to install optimal corrosion control treatment, as specified in § 141.84 of this part.

(iv) If the pH is less than 8.0 in more than five percent of the required samples, the State-approved treatment plan must require the system to install optimal corrosion control treatment, as specified in § 141.84 of this part.

(c) Each system must meet the no-action levels specified in paragraph (b)(1) of this section, or submit or apply for a State-approved treatment plan as specified in § 141.84 of this part, according to the following schedule (which corresponds to one year after the monitoring required by §141.86(b) of this part is to be completed):

System size (# persons served)	Deadline
>3,300	(enter date 27 months after publication of final rule).
500–3,300	(enter date 39 months after publication of final rule).
<500	(enter date 51 months after publication of final rule).

(d)(1) A system that fulfills the treatment technique requirements of paragraph (a) of this section by meeting the no-action levels in paragraph (b)(1) of this section, by the deadline specified in paragraph (c) of this section, and fails to meet one or more of the no-action levels during a subsequent monitoring period (the length of the monitoring period, which varies by system size and system type, is specified in § 141.86 of this part), must comply with paragraph (b)(2) of this section. Such a system must submit or apply for a State-approved treatment plan under §141.84 of this part within one year after any such failure to meet the no-action level(s).

(2) A system that meets the no-action levels in paragraph (b)(1) of this section after implementing a treatment plan approved by the State under § 141.84 of this part must continue to meet the no-action levels each subsequent monitoring period.

Failure to meet one or more of the no-action levels is a violation of the treatment technique requirement.

(3) A system that does not meet the no-action levels after implementing the treatment plan approved by the State under § 141.84 of this part and demonstrating to the State that it has minimized the corrosivity of its water toward lead must operate within the parameters approved by the State as optimal for reducing corrosion of lead. Failure to operate within one or more of the parameters is a violation of the treatment technique requirement.

§ 141.84 Treatment plan.

The treatment plan describes the specific steps a system must take to comply with the treatment technique requirement in § 141.83(a) of this part and specifies a schedule for completing these steps for systems that do not meet one or more no-action levels specified in § 141.83(b) of this part. Failure to complete any step by the deadline specified in the plan for that step is a violation of the treatment technique requirement.

(a)(1) As specified in § 141.83(b)(2) of this part, the treatment plan must require optimal corrosion control treatment when:

(i) The system exceeds the no-action average lead level as specified in § 141.83(b)(1)(i) of this part;

(ii) The system exceeds the no-action copper level as specified in § 141.83(b)(1)(iii) of this part; or

(iii) The system fails to meet the no-action pH level as specified in § 141.83(b)(1)(iv) of this part.

(2) Systems serving more than 3,300 persons must develop and submit a treatment plan to the State for review and approval. The treatment plan must explain how the system will achieve the following steps, and provide a schedule for completing each step:

(i) Design and implementation of appropriate pipe loop, laboratory, pilot scale, and/or field studies demonstrating reductions of lead levels in simulated morning first draw and service connection samples that correspond to application of various corrosion control treatments, such as:

(A) pH adjustment;

(B) Alkalinity adjustment; and/or

(C) Addition of corrosion inhibitors;

(ii) Analysis of the data generated in paragraph (a)(2)(i) of this section that identifies the water quality conditions under which lead levels in morning first draw and service connection samples are expected to be minimized;

(iii) Installation and operation of corrosion control treatment in the water supply system as a whole to ensure delivery to residences of water meeting the water quality conditions identified in paragraph (a)(2)(ii) of this section within three years after the State approves the treatment plan;

(iv) Monitoring to determine the effectiveness of the corrosion control treatment by comparing lead levels in morning first draw and service connection samples at residences designated for monitoring, as specified in § 141.86 of this part, after installation of corrosion control treatment with:

(A) The no-action levels for lead specified in § 141.83(b)(1) of this part, and

(B) The lead levels in morning first draw and service connection samples predicted based on the analysis performed in paragraph (a)(2)(ii) of this section;

(v) Additional adjustment of the corrosion control treatment if the lead levels in morning first draw or service connection samples from residences designated for monitoring, as specified in § 141.86 of this part, exceed the no-action level specified in § 141.83(b)(1)(i) of this part; and

(vi) If the system is still exceeding the no-action levels after application of all treatment, an analysis of all treatment and resulting lead levels must be prepared and submitted to the State.

(3) For systems serving 3,300 or fewer persons, the system must request a treatment plan from the State. The State will specify the required treatment. The treatment plan must include the following steps, and a schedule for completing each step:

(i) Installation and operation in the water supply system of the corrosion control treatment specified by the State (such as pH control, alkalinity control, and/or use of corrosion inhibitors) within three years after the State issues the treatment plan;

(ii) Monitoring to determine the effectiveness of the corrosion control treatment by comparing lead levels in morning first draw and service connection samples at residences designated for monitoring, as specified in § 141.86 of this part, after installation of corrosion control treatment with the applicable no-action levels for lead specified in § 141.83(b)(1) of this part; and

(iii) Additional adjustment of the corrosion control treatment if the lead levels in morning first draw or service connection samples from residences designated for monitoring, as specified in § 141.86 of this part, exceed the no-action level specified in § 141.83(b)(1)(i) of this part.

(4) If lead levels in morning first draw or service connection samples continue to exceed the no-action level specified in § 141.83(b)(1)(i) of this part after completion of the steps described in paragraph (a)(2) of this section (for systems serving more than 3,300 persons) or paragraph (a)(3) of this section (for systems serving 3,300 or fewer persons), the State must evaluate the treatment and monitoring data and determine whether the corrosion control treatment applied by the system is optimal, i.e., minimizes the corrosivity of water towards lead. If the State determines that the system has minimized the corrosivity of water towards lead i.e., the treatment is optimal, the system must continue to operate within the parameters specified by the State as constituting optimal treatment. Final operating parameters specified by States must account for seasonal variations in water corrosivity and lead levels.

(5) Systems serving more than 3,300 persons that wish to change other concurrent treatments that might reduce the effectiveness of the approved corrosion control treatment, or experience significant change in the population served or in the extent of the distribution system, would be required to submit to the State for approval new corrosion control data from studies which reflect the new conditions under which the supplier wished to operate, except for temporary changes required to respond to an emergency situation. Permanent operating conditions must assure that treatment is optimal Temporary changes in treatment must be reported to the State within five days. Changes in treatment lasting more than five days are considered permanent changes in treatment.

(6) Systems serving less than 3,300 persons that wish to change other concurrent treatments that might reduce the effectiveness of the approved corrosion control treatment, or experience significant change in the population served or in the extent of the distribution system, would be required to notify the State of the proposed changes. States may disapprove the changes and require any modifications necessary to assure that treatment is optimal.

(7) States may, at their discretion, periodically review and revise approved treatment plans and final operating parameters as warranted, to ensure that no-action levels continue to be met or that treatment remains optimal.

(b)(1) The treatment plan must contain public education provisions when:

(i) A system exceeds the no-action average lead level specified in § 141.83(b)(1)(i) of this part; or

(ii) A system exceeds the no-action maximum lead level specified in § 141.83(b)(1)(i)(ii) of this part.

(2) A system must conduct a public education program in accordance with its State-approved treatment plan once the State approves it (for systems serving more than 3,300 persons) or issues it (for systems serving 3,300 or fewer persons), as long as paragraph (b)(1)(i) or (ii) of this section applies.

(3) The portion of the treatment plan that addresses the pubic education program must conform to the requirements of § 141.85 of this part.

§ 141.85 Public education program.

The public education program must be designed to provide users served by the system with information that will enable them to modify their water use behavior or take other measures to mitigate the risks to human health associated with excess levels of lead in drinking water that cannot be controlled by central water treatment.

(a) *Targeting of the public education program.* Community water systems must either:

(1) Direct the public education program required by this section to the entire population of users served by the system; or

(2) Based on the results of the materials evaluation described in § 141.86(d) of this part or any other

information available to the system, target the public education program to particular segments of the consumer population that may be receiving drinking water at the tap that exceeds the no-action levels of § 141.83(b)(1)(i) or (ii) of this part. A community water system must identify such segments on the basis of factors that include but are not limited to:

(i) Known increased potential for exposure to excess levels of lead in drinking water (e.g., areas where lead service lines are known to exist, areas where very new or very old buildings exist, areas located at the ends of the water distribution system); or

(ii) Known to be more susceptible to the adverse effects of lead (e.g., children, pregnant women, or groups of individuals exposed to additional sources of lead, including occupational exposure or other environmental exposure).

(b) *Supplemental monitoring and notification of results.* (1) As part of the public education program, community water systems must offer to sample or arrange to have sampled by a certified Laboratory the water of any customer who requests it to determine the lead content of drinking water at the customer's residence. The system is not required to pay for the sampling or analysis, nor is the system required to collect and analyze these samples itself.

(2) Each customer whose residence is sampled as part of the system's compliance monitoring, as specified in § 141.86 of this part, and each customer who requests supplemental monitoring, as specified in paragraph (b)(2) of this section, must be informed of the results of the analysis performed on his or her residence.

(c) *Content of the public education program.* The public education program required of community and non-transient non-community systems by this section must include but is not limited to the following:

(1) Information explaining the causes of excess levels of lead in drinking water. Such causes include but are not limited to:

(i) Excess levels of lead in source water;

(ii) The corrosivity of water toward plumbing materials containing lead;

(iii) The presence of lead pipes or connections;

(iv) The existence of newly-installed lead solders (generally less than five years old);

(v) Water remaining in contact with plumbing containing lead for extended periods of time;

(vi) The use of water from the hot water tap for consumption; and

(vii) Grounding of electrical systems to lead-bearing plumbing.

(2) Information explaining the potential health effects of exposure to excess levels of lead. Such effects include but are not limited to:

(i) Delayed neurological and physical development in children and infants;

(ii) Impaired cognitive performance in children (as measured by IQ tests, performance in school, and other means);

(iii) Elevations in blood pressure in adults;

(iv) Interference with heme synthesis (the ability of blood to absorb oxygen);

(v) Interference with vitamin D metabolism;

(vi) Anemia (low red blood-cell count);

(vii) Kidney damage:

(viii) Impaired reproductive function;

(ix) Complications in pregnancy and other fetal effects; and

(x) Potential carcinogenicity.

(3) Information explaining that the risks associated with lead in drinking water may be aggravated by exposure to lead from other sources. These sources include but are not limited to:

(i) Occupational or home hobby exposures (e.g., exposure from smelting, electronics, or other operations that involve the use of lead);

(ii) Inhalation of airborne lead from paint dust, leaded gasoline engine exhaust, and smelter or battery recycling; and

(iii) Ingestion of lead from lead paint chips, lead that settles out of the air as dust and dirt, and lead-contaminated crops and foodstuffs, including contamination from lead-soldered food containers and improperly glazed pottery.

(4) Actions that have been taken by the system or community to evaluate, quantify, or reduce the levels of lead in drinking water. Such actions include but are not limited to:

(i) Modifications to the applicable plumbing code to ban the use of lead solders, fluxes, and pipes, pursuant to the lead ban of Subpart E of this part;

(ii) Compliance monitoring conducted pursuant to § 141.86 of this part and any supplemental monitoring conducted pursuant to paragraph (b) of this section; and

(iii) Other actions the system has taken to evaluate, quantify, or reduce the levels of lead in drinking water.

(5) Information that the user may use to evaluate the probability that excess levels of lead exist in the user's drinking water supply. Such information must include the likelihood that excess lead levels exist in water as it leaves the system and the potential for further increases in lead levels as a result of corrosion of water distribution system components. In addition, the public education program must recommend that the user:

(i) Determine whether the user's faucets, water holding tanks, service lines, pipes, and soldered joints contain lead;

(ii) Contact the system for additional information; and

(iii) If the potential for excess levels of lead in the user's drinking water appears to be substantial, have the user's water analyzed to determine the water's lead content.

(6) Actions that the user can take to reduce short-term and long-term exposures to lead in drinking water. Such actions include but are not limited to:

(i) Flushing each water tap for at least three minutes, or until the water is as cold as it will get, before any water from that tap is consumed or used for any type of cooking or preparation of food, beverages (including ice), or baby formula;

(ii) Replacing privately-owned and privately-controlled lead service lines with pipes that are lead-free;

(iii) Ensuring that all plumbing repair work is performed using lead-free pipe, solder, and flux (as defined in Subpart E of this part); and

(iv) If allowed by the local electrical code, providing an electrical ground for the user's wiring other than the user's plumbing system.

(d) *Delivery of the public education program by community water systems.* (1) Community water systems must deliver the public education program in a form that is tailored to the nature and size of the target population, as determined under paragraph (a) of this section. The system must present all materials associated with the public education program in plain English (and in other languages where appropriate) that can be understood readily by the layperson. The means by which the system delivers the public education program may include but are not limited to:

(i) Public service announcements broadcast on radio and television stations;

(ii) Public announcements published in local newspapers;

(iii) Public meetings;

(iv) Informational notices in water utility bills;

(v) Pamphlets or brochures; and

(vi) In combination with the means specified in paragraphs (d)(1) (i) through (v) of this section, local telephone hotlines.

(2) When designing and implementing a public education program, community systems water must, to the extent practicable, coordinate with appropriate local authorities including but not limited to:

(i) The city, county, or municipal council;

(ii) The Mayor's, City Administrator's, or County Commissioners' office;

(iii) The local department of public health;

(iv) The local department of environmental protection; and

(v) The local government office responsible for administering lead-screening programs, if not listed elsewhere in this paragraph.

(3) Community water systems must repeat public education programs at least quarterly as long as the level of lead in drinking water exceed one or both no-action levels specified in § 141.83(b)(1) (i) and (ii) of this part during the previous monitoring period.

(e) *Delivery of the public education program by non-transient non-community water systems.* Non-transient non-community water systems must:

(1) Publicly post informational posters on lead in drinking water in a public place;

(2) Hold at least one public meeting annually to educate water consumer's about lead in drinking water and to answer questions on the subject; and

(3) Distribute brief informational pamphlets on lead in drinking water at least quarterly.

(f) *Evaluation of the public education program.* Community water systems serving more than 10,000 persons must, within 12 months after a public education program is undertaken, and every 24 months thereafter, evaluate the extent to which the program is effective. As part of the evaluation, the system must demonstrate to the State that, as a result of the public education program, users' knowledge about lead in drinking water enables them to alter voluntarily their water use patterns to reduce consumption of lead-contaminated water. The demonstration must be based on public survey (by mail, telephone, or in person) to evaluate the effectiveness of the public education program. Based on the results of this evaluation, the system must modify subsequent public education efforts, if such modification is determined by the State to be necessary to ensure the effectiveness of the public education program in reducing lead consumption.

§ 141.86 Analytic and monitoring requirements for lead and copper MCLs and treatment technique requirements.

(a) *Analytic provisions.* Only the analytic methods specified below, or methods otherwise approved by EPA, may be used to determine compliance with the MCLs for lead and cooper specified in § 141.82(a) of this part and to determine whether a system meets the no-action levels specified in §141.83(b)(1) of this part. Results must be reported in the units specified by the analytic method used. The following methods are incorporated by reference with the approval of the Director of the Federal Register under 5 U.S.C. 552(a):

(1) Lead:

(i) Method 239.2, Atomic Absorption Furnace Technique.

"Methods of Chemical Analysis of Water and Wastes," EPA Environmental Monitoring and Support Laboratory, Cincinnati, Ohio (EPA–600/4–79–020), March 1985. Available from ORD Publications, CERI, EPA, Cincinnati, Ohio 45268. (For analyzing lead and copper, the technique applicable to total metals must be used.) and;

(ii) Method D3559–85D, Atomic Absorption Furnace Technique.

Annual Book of ASTM Standards, Vol. II.01, American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103; and

(iii) Method 3043Q, Atomic Absorption Furnace Technique.

"Standard Methods for the Examination of Water and Wastewater," 16th edition, American Public Health Assoication, American Water Works Association, Water Pollution Control Federation, 1985.

(2) Copper:

(i) Method 220.2

"Methods of Chemical Analysis of Water and Wastes," EPA Environmental Monitoring and Support Laboratory, Cincinnati, Ohio (EPA–600/4–79–020), March 1985. Available from ORD Publications, CERI, EPA, Cincinnati, Ohio 45268. (For analyzing lead and copper, the technique applicable to total metals must be used.); and

(ii) Method D1688–84F

Annual Book of ASTM Standards, Vol. II.01, American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103; or

(iii) Method 304, Atomic Absorption Furnace Technique;

"Standard Methods for the Examination of Water and Wastewater," 16th edition, American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1985; and

(iv) Method 220.1, Atomic Absorption Direct Aspiration;

"Methods of Chemical Analysis of Water and Wastes," EPA Environmental Monitoring and Support Laboratory, Cincinnati, Ohio (EPA–600/4–79–020), March 1985. Available from ORD Publications, CERI, EPA, Cincinnati, Ohio 45268. (For analyzing lead and copper, the technique applicable to total metals must be used.); and

(v) Method D–1687–84D or E, Atomic Absorption Direct Aspiration;

Annual Book of ASTM Standards, Vol. II.01, American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103; and

(vi) Method 303A or B, Atomic Absorption Direct Aspiration; "Standard Methods for the Examination of Water and Wastewater," 16th edition, American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1985; and

(vii) Method 200.7A, Inductively-coupled plasma.

"Inductively-Coupled Plasma Atomic Emission Analysis of Drinking Water," Appendix to Method 200.7, September 1985, U.S. Cincinnati, Ohio 45268.

(3) pH:

(i) Method 150.1, Electrometric.

"Methods of Chemical Analysis of Water and Wastes," EPA Environmental Monitoring and Support Laboratory, Cincinnati, Ohio (EPA–600/4–79–020), March 1985. Available from ORD Publications, CERI, EPA, Cincinnati, Ohio 45268.

(ii) Method D1293–84A Electrometric.

Annual Book of ASTM Standards, Vol. II.01, American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103; and

(iii) Method 423, Electrometric.

"Standard Methods for the Examination of Water and Wastewater," 16th edition, American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1985.

Each analysis must be performed by a laboratory approved by EPA or the State except that analyses of pH must be conducted in the field by a technician approved by the State as specified in Part 136 of this title.

(4) Analyses under this section shall only be conducted by laboratories that have received approval by EPA or the State. To obtain approval, laboratories must:

(i) Analyze performance evaluation samples which include lead and copper provided by the EPA Environmental Monitoring and Support Laboratory or equivalent samples provided by the State; and

(ii) Achieve quantitative acceptance limits as follows:

(A) Lead: ±30 percent of the actual amount in the Performance Evaluation sample when the active amount is greater than 0.005 mg/l,

(B) Copper: ±10 percent of the actual amount in the Performance Evaluation sample when the active amount is greater than 0.050 mg/l, and

(C) pH: ±0.1 pH units of the actual pH when actual pH is in the range of 0–14 pH units;

(iii) Achieve method detection limits according to the procedures in Appendix B of Part 136 of this title as follows:

(A) Lead: 0.001 mg/l; or

(iv) Be currently approved by EPA or the State to perform analyses to the specifications described in paragraph (a)(5) of this section.

(5) States have the authority to allow the use of previously collected monitoring data for purposes of compliance monitoring, if the data were collected and analyzed in accordance with the requirements of this section.

(6) All lead levels measured between the PQL of 0.005 mg/l and the MDL of 0.001 mg/l must be averaged as reported. All levels below the MDL of 0.001 mg/l must be reported as zero and average as such. Lead levels reported below an MDL larger than 0.001 mg/l must be reported as the MDL and averaged as such.

(b) *Phased-in monitoring program.* Systems must begin monitoring to determine compliance with the MCLs specified in § 141.82(a) of this part, and to determine wheter the no-action levels specified in § 141.83(b)(1) of this part are met, according to the following schedule:

System size (# of persons served)	Monitoring to being no later than	Monitoring to conclude no later than
>3,300	[enter date 3 months after publication of final rule]	[enter date 15 months after publication of final rule]
500–3,300	[enter date 15 months after publication of final rule]	[enter date 27 months after publication of final rule]
>500	[enter date 27 months after publication of final rule]	[enter date 39 months after publication of final rule]

(c) *Monitoring provisions for lead and copper MCLs.* (1) Samples must be collected at every entry point to the water distribution system, except when multiple wells draw from a single aquifer and there is no treatment, in which case, the State may designate one or more representative wells for monitoring. When multiple samples are required under this paragraph, states may allow up to 5 samples to be composited for analysis. If the lead or copper level in the composited sample exceeds one-fifth the lead or copper MCL specified in § 141.82 of this part, each of the entry points represented in the composite sample must be resampled individually for whichever contaminant exceeded one-fifth the MCL. This means that for lead, the laboratory must be able to measure levels down to 0.001 mg/l for compositing to be allowed. A composited sample that contains less than or equal to 0.001 mg/l of lead would be deemed in compliance with the MCL without sampling each well represented in the composited sample.

(2) Non-transient non-community water systems must sample water for lead and copper in at least one sample per entry point (except as specified in paragraph (c)(1) of this section) every five years. Non-transient non-community water systems are not eligible for reduced monitoring frequency.

(3) Community water systems must sample water for lead and copper in at least one sample per entry point as follows:

System size (persons served)	Minimum # Samples per Entry Point/ Monitoring Period
>500	1/Year.
>500 using ground water	1/Year.
>500 using surface water or a combination of surface water and ground water.	1/Quarter.

(4) For community water systems, if no violation of the MCL has occurred within the most recent 2 years of monitoring, the State may reduce the monitoring frequency to no less than the following:

System size (persons served)	Minimum number samples/entry point/ monitoring period
>500	1/year, every 5 years.
>500 using ground water	1/year, every 5 years.
>500 using surface water or a combination of surface water and ground water.	1/quarter for 1year, every 5 years.

(5) If the result of an analysis performed under paragraph (c) of this section indicates that the level of copper or lead at any sampling point exceeds the MCL specified in § 141.82(a) of this part, the State may allow the system to obtain and analyze one additional sample at the same sampling point within 2 weeks of the original sample.

(6) When the only analysis, or the average of the two analyses, as appropriate, made pursuant to paragraph (c)(5) of this section exceeds the MCL at any sampling point, the system is in violation of the MCL and must notify the State pursuant to § 141.31 of this part and give notice to the public pursuant to § 141.32 of this part. The system must perform increased monitoring at this sampling point at a frequency determined by the State until: (i) The MCL has not been exceeded in two successive monitoring periods of the increased monitoring program; or (ii) a monitoring schedule imposed as a condition of a variance, exemption, or enforcement action becomes effective.

(d) *Monitoring provisions for corrosion control treatment technique requirements for community water systems.*—(1) *Materials evaluation and identification of sampling group.* (i) By the applicable data specified in paragraph (b) of this section, each community water system must complete a materials evaluation in the community adequate to identify a group of residences from which samples required by this section must be taken. Systems are to select single-family houses, except that they may include apartments and other multiple-family housing where such housing constitutes more than 20 percent of the housing served by the community. This group of residences must be served by the ends of the distribution system and have plumbing systems that either contain lead solder that is less than 5 years old or have lead service connections or interior lead pipes. To the extent possible, the group of residences shall have an equal number of residences from each of these two categories. To identify these residences, systems must use the information collected by pursuant to § 141.42(d) of this part. As necessary, systems must also review the following:

(A) Plumbing codes, permits, and records in the files of the community building department that indicate the plumbing materials installed within residences;

(B) Inspections and records of the distribution system that indicate the material composition of the distribution lines, service lines, and connections;

(C) Existing water quality information, including results of prior analyses of water in the system or individual residences, indicating residences in which the lead level of the water may be of concern; and

(D) Design plans of the distribution system indicating residences that are served by the ends of the distribution system.

(ii) The number of residences in the sampling group must be no less than 50 percent greater than the number of sample points required for compliance with this section. If, based on the materials evaluation, a community water system cannot identify a sufficient number of residences with the specified characteristics, the system must demonstrate this to the State by:

(A) Submitting a report on the materials evaluation documenting that lead pipe was never used for service lines, goosenecks, pigtails, or interior plumbing pipes or that all such plumbing has been replaced, in those portions of the community that are served by the ends of the distribution system; and/or

(B) Demonstrating that the community has had in effect and successfully enforced for a minimum of five years a ban on lead solder use or that no lead solder was used in the construction of residences in those portions of the community served by the ends of the distribution system.

(iii) A system that meets either of the conditions in paragraph (d)(1)(ii) of this section must add to the sampling group, as appropriate, depending upon which of the conditions in paragraph (d)(1)(ii) of this section is met, residences located elsewhere within the distribution system that either:

(A) Are served by lead service connections; or

(B) Contain lead solder that is less than five years old. If the community water system still cannot establish a sampling group sufficiently large to meet the monitoring requirements of this section, the system must add to the sampling group the number of residences with lead solder served by the ends of the distribution system, irrespective of the lead content of the system and the age of lead solder in plumbing of the residences, that will increase the size of the sampling group sufficiently to meet the monitoring requirements of this section.

(iv) States may disapprove proposed monitoring plans. Systems with disapproved plans must revise the plans and obtain State approval before monitoring commences. A system with a disapproved monitoring plan is in violation of this section until the State approves a revised plan.

(2) *Sample collection.* Community water systems must obtain a one-liter sample of water from the cold-water kitchen tap of each residence monitored in the sampling group each monitoring period. In residences selected because they have new lead solder, the system must collect a morning first draw sample. In residences selected because they have lead service connections, the system must collect a service connection sample. The service connection sample consists of a sample from:

(i) The tap after the morning first draw water changes temperature;

(ii) The tap after flushing the water in the household plumbing (calculated based on pipe diameter and length to the tap from the connection); or

(iii) Directly from the service line itself.

In residences with both new lead solder and a lead service connection, the system may take a morning first draw sample and a service connection sample and count it as two residences in its pool. Systems must take subsequent samples from the same residences that were sampled during the initial monitoring period, except that, to the extent this is not possible, systems may, with State concurrence, take a sample from another residence remaining in the sampling group with the same characteristics as the initial site. Systems collecting only one set of samples annually must collect all samples during the months of July, August, or September.

(3) *Frequency of monitoring.* By the applicable date specified in paragraph (b) of this section, each community water system must begin monitoring in accordance with paragraph (a) of this section to determine whether its water meets the no-action levels specified in § 141.83(b)(1) of this part. Community water systems must monitor the sampling group at the following minimum frequency:

System size (persons served)	Minimum number samples/monitoring period
>100,000	50/Quarter.
10,001 to 100,000	30/Quarter.
3,301 to 10,000	20/Quarter.
500 to 3,300	10/Year, Every Other Year.
<500	10/Year, Every Five Years.

(4) *Reduced frequency of monitoring.* If, throughout the most recent four quarters, a community water system serving more than 3,300 persons has met the no-action levels specified in § 141.83(b)(1) of this part or has not departed from the operating parameters specified by the State after implementation of a State-approved treatment plan under § 141.84 of this part, the State may reduce the monitoring frequency required by this section to no less than the following minimum frequency:

System size (persons served)	Minimum number samples per monitoring period
>100,000	50/Year.
10,001 to 100,000	30/Year.
3,301 to 10,000	20/Year.

(5) Systems monitoring once per year under this schedule must do so during the months of July, August, or September.

(e) *Monitoring provisions for corrosion control treatment technique requirements for non-transient non-community water systems.*—(1) *Identification of sampling group.* By the applicable date specified in paragraph (b) of this section, each nontransient non-community water system must identify all buildings served by the system. Such buildings will comprise the sampling group.

(2) *Sample collection.* Non-transient non-community water systems must obtain a one-liter morning first draw sample from the tap or a service connection sample (if the building has a lead service connection) in each building typically used to draw water for human consumption. The service connection samples may be drawn by any of the three methods specified in paragraph (d)(2) of this section. At least one sample must be taken from every building in the sampling group each monitoring period.

(3) *Frequency of monitoring.* By the applicable date specified in paragraph (b) of this section, each non-transient non-community water system must begin monitoring in accordance with paragraph (a) of this section to determine whether its water meets the no-action levels specified in §141.83(b)(1) of this part. Non-transient non-community water systems must monitor the sampling group at least annually, during the months of July, August, or September.

(4) *Reduced frequency of monitoring.* Non-transient non-community water systems are not eligible for reduced monitoring frequency.

(f) Only samples collected in compliance with section 141.86(d)(1)(i) of this part can be used to determine whether no-action levels described in § 141.83 of this part have been met.

§ 141.87 Reporting and recordkeeping.

(a) All systems that serve more than 500 persons must report to the State the results of all monitoring required by this subpart within 10 days of the end of

each calendar quarter the system is in operation for any period of time. Systems that serve 500 or fewer persons must report such results to the State within 10 days of the end of each calendar year such system is in operation for any period of time. All systems must certify that the information submitted under this section is accurate. To the extent systems perform more monitoring in conformance with § 141.86(a) of this part than required under § 141.86 of this subpart, systems must include the results of the additional monitoring in their reports to the State.

(b) Reporting under this section must include the identification and location of sampling sites monitored under § 141.86(d) of this part and, the first time a site is sampled, the rationale for choosing the site.

(c) Systems operating under a State approved treatment plan to install or improve corrosion control must, according to a schedule established by the State in the treatment plan, report to the State the system's progress in completing the treatment plan's interim steps (see §141.84(a)(2) of this part).

(d) Systems operating under an approved treatment plan containing a public education program must detail the system's progress in completing the public education program requirements in the reports submitted to the State under paragraph (c) of this section, this report must include. As specified in § 141.85(f) of this part, this report must include data to the State that indicate that, as a result of the public education program, the users' knowledge about lead in drinking water enables them to alter voluntarily their water use patterns to reduce consumption of lead-contaminated water.

(e) EPA may require a system to establish and maintain such records, reports, or information as the Administrator deems necessary to determine whether the system has acted or is acting in compliance with this subpart.

PART 142—NATIONAL PRIMARY DRINKING WATER REGULATIONS IMPLEMENTATION

1. The authority for Part 142 continues to read as follows:

Authority: 42 U.S.C. 300g-2, 300g-3, 300g-4, 300g-5, 300g-6, 300j-4, and 300j-9.

2. Section 142.14 is amended by revising paragraphs (a)(1)(iii) and (d)(2), reserving paragraphs (d)(4), (5), and (6), adding paragraphs (d)(7), (d)(8), (d)(9), and (d)(10), to read as follows:

§ 142.14 Records kept by States.

(a) * * *

(1) * * *

(iii) The analytical results, set forth in a form that makes possible comparison with the limits specified in §§ 141.14, §141.71, §141.72, §141.73, § 141.82, and no-actions levels in § 141.83 of this chapter.

* * * * *

(d) * * *

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(2) Records of any State approvals, including approvals of treatment plans required by § 141.83 of this chapter, and the grounds for such approvals;

(3) * * *

(4) [Reserved]—(6)

(7) Records of any reductions in monitoring frequency authorized by § 141.86(c)(4) or § 141.86(d)(4) of this chapter, specifying the new frequency;

(8) Records of any requirements to perform increased monitoring, as required by § 141.86(c)(6) the frequency of such monitoring;

(9) Records of any determination under § 141.84 of this chapter that a system has minimized the corrosivity of its water, the evidence supporting this determination, and the final approved operating parameters.

(10) Records of a system's evaluation of its public education program, as required by § 141.85(f) of this chapter, and of any State determination that the system must modify subsequent public education efforts.

3. Section 142.15 is amended by reserving paragraphs (b) (3) and (4) and adding paragraphs (b)(5), (b)(6), (b)(7), (b)(8), (b)(9), (b)(10), and (b)(11) to read as follows:

§ 142.15 Reports by States.

* * * * *

(b) * * *

* * * * *

(3)—(4) [Reserved.]

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(5) A list, including system identification numbers, of systems that have been authorized to reduce their monitoring frequencies in accordance with § 141.86(c)(4) and/or § 141.86(d)(4) of this chapter and the new monitoring frequencies;

(6) a list, including system identification numbers, of systems that are required to perform increased monitoring under § 141.86(c)(6) of this chapter and the new monitoring frequency.

(7) A list, including system identification numbers, of systems that have demonstrated to the State that an insufficient number of residences were available for sampling, as specificed by § 141.86(d)(1) of this chapter;

(8) A list, including system identification numbers, of systems that exceed one or more no-action levels and the level(s) exceeded.

(9) A list, including the system identification numbers, of systems serving 3,300 or more persons that have received State approval for their treatment plans, as specified in § 141.84 of this chapter and a list, including system identification numbers, of the system serving fewer than 3,300 persons which have received treatment plans from the State, or have recevied State approval for treatment plans submitted by the system;

(10) A list, including system identification numbers, of systems that have demonstrated that they have minimized the corrosivity of their water as required by § 141.84 of this chapter. The report must also contain for each system the new operating parameters with which the system must comply.

(11) A report of the results of the evaluations of public education programs required by § 141.85(f) of this chapter and of any State determination that the system must modify subsequent public education efforts.

4. Section 142.17 is added to read as follows:

§ 142.17 Special primacy requirements.

(a)—(b) [Reserved.]

(c) *Special primacy requirements for States to adopt 40 CFR Part 141, Subpart I, Control of Lead and Copper.* An application for approval of a State program revision that adopts 40 CFR Part 141, Subpart I, Control of Lead and Copper, must contain:

(1) The text of the State statute or regulations containing the procedures or criteria for determining increased monitoring frequency (in accordance with § 141.86(c)(4) and/or § 141.86(d)(4) of this chapter) including a procedure for notifying the system of the new monitoring requirements.

(2) The text of the State statute or regulations requiring community water systems to conduct a materials evaluation and specifying the procedures for demonstrating to the State that sufficient residence with the required characteristics are not available (in accordance with § 141.86(d)(1) of this chapter). The regulations shall include the criteria the State will use to evaluate the community water system's demonstration. Such criteria must be the same or more stringent than those specified in § 141.86(d)(1) of this chapter.

(3) The text of the State statute or regulations specifying enforceable design and operating criteria for treatment techniques designed to control the corrosivity of water. These techniques include pH adjustment, alkalinity adjustment, and the addition of corrosion inhibitors. In addition, the regulations must contain a procedure (e.g., a permit or certification system) to ensure that the design and operating criteria are met on a continuous basis.

(4) The text of the State statute or regulations specifying the procedures and criteria the State will use to evaluate and approve a treatment plan submitted for approval by systems serving more than 3,300 persons (in accordance with § 141.84 of this chapter); the criteria the State will use to determine that corrosivity has been minimized (including the data the system must submit to show that water corrosivity has been minimized) and select approved operating parameters and a method for informing the system of its approved operating parameters.

(5) Text of the State statute or regulations specifying procedures and criteria the State will use to issue or approve treatment plans for systems serving 3,300 or fewer persons, including procedures the system must follow to request a plan, the criteria the state will use to determine that corrosivity has been minimized, and the procedures the State will use to inform the system of its new operating parameters.

(6) Procedures and criteria the State will use in evaluating the data submitted by the system on the effectiveness of its public education program and in determining if the system must modify subsequent public education efforts.

5. A new § 142.63 is added to read as follows:

§ 142.63 Variances from the maximum contaminant levels for lead and copper.

(a) The Administrator, pursuant to section 1415(a)(1)(A) of the Act, hereby identifies the following as the best technology, treatment techniques, or other means available for achieving compliance with the maximum contaminant levels for lead and copper: Coagulation/filtration; ion exchange; lime softening; reverse osmosis.

(b) A state shall require community water systems and non-transient, non-community water systems (hereinafter referred to as "systems") to install and/or use any treatment method identified in paragraph (a) of this section as a condition for granting a variance. If, after the system's installation of the treatment method, the system cannot meet the requirements of § 141.82(a) of this chapter, that system shall not be eligible for a variance under the provisions of section 1415(a)(1)(A) of the Act unless the system demonstrates to the State that lead levels or copper levels, as appropriate, would not pose an unreasonable risk to health.

(c) The State may require a system to provide bottled water or point-of-use devices or other means as a condition of granting a variance from the requirements of § 141.82(a) of this chapter to avoid an unreasonable risk to health.

(d) Systems that use bottled water as a condition of receiving a variance from the requirements of §141.82(a) of this chapter must meet the requirements in either paragraph (d)(1) or (d)(2) of this section in addition to the requirements in paragraph (d)(3) of this section:

(1) The State must require and approve a monitoring program for bottled water. The system must develop and implement a monitoring program that provides reasonable assurances that the bottled water meets all MCLs. The system must analyze a representative sample of the bottled water for all contaminants for which MCLS are promulgated under Part 141 of this chapter during the first quarter it supplies the bottled water to the public and annually thereafter. The system must provide results of the monitoring program to the State annually.

(2) The system must receive a certification from the provider of bottled water that the bottled water supplied has been taken from an "approved source" as defined in 21 CFR 129.3(a); the bottled water company has conducted monitoring in accordance with 21 CFR 129.80(g)(1) through (3); and the bottled water does not exceed any MCLs or quality limits as set out in 21 CFR 103.35, 110, and 129. The system shall provide the certification to the State the first quarter after it supplies bottled water and annually thereafter.

(3) The system is fully responsible for the provision of sufficient quantities of bottled water, for consumption but not washing purposes, to every customer of the system via door-to-door bottled water delivery.

(e) Systems that use point-of-use devices as a condition for obtaining a variance from the MCLs for lead or copper must meet the following requirements:

(1) It is the responsibility of the system to operate and maintain the point-of-use treatment device.

(2) The system must develop a monitoring plan and obtain State approval for the plan before point-of-use devices are installed for compliance. This monitoring plan must provide health protection at least equivalent to a monitoring plan for central water treatment.

(3) The system must properly apply effective technology under a plan approved by the State and must maintain the microbiological safety of the water.

(4) The system must meet all State requirements regarding adequate certification of performance, field testing, and, if not included in the certification process, a rigorous engineering design review of the point-of-use devices.

(5) The design and application of the point-of-use devices must consider the tendency for increases in heterotrophic bacteria concentrations in water treated with activiated carbon. It may be necessary to use frequent backwashing, post-contactor disinfection, and heterotrophic plate count monitoring to ensure that the microbiological safety of the water is not compromised. The system must obtain any necessary right-of-entry to enable the State and EPA to inspect point-of-use devices.

(6) The system must protect all users. Every building connected to the system must have a point-of-use device installed, maintained, and adequately monitored. The system must subject every building to treatment and monitoring, and must ensure that the rights and responsibilities of the system customer convey with title upon sale of property.

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